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STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA

The Influence of Distractions on the Formation of Judgments in Lifted Weight Experiments

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STATEMENT OF PROBLEM[1]

The experiments reported here deal with the influence of distractions on the formation of judgments on lifted weights. These experiments afford particularly favorable conditions for such an investigation. The objective conditions can be kept fairly constant and former experience has shown that the subjective conditions undergo but little variation. These experiments were made in the first time order, that is, the standard weight was always lifted first and the comparison weight second. The distractions used divide the experiments into two groups. In the first group the distraction was a continuous auditory stimulus produced by an electric buzzer when the comparison weight was lifted. In the second group it was the counting of discrete sounds given during the lifting of either the standard or the comparison weight. In both groups the distraction was given only on the standard or comparison weight because we wished to have experiments that would differ as little as possible from series in which no kind of distraction was used. This made it undesirable to have the distraction on both weights of a pair in one series while we did not have it on either weight in the other series. Another important consideration is that the subjective conditions be the same for both series and this can not be guaranteed if the experiments are carried on at different times. For this reason we decided that the experiments in the two series should be carried on simultaneously and that experiments with the distraction should alternate with those free from it.

The first arrangement makes use of what is called the single task method or the method of distraction and the second is the double task or the method of the distribution of attention.[2]

[1] I wish to thank Professor Witmer for placing at my disposal the facilities of the laboratory, Assistant-Professor Twitmyer for invaluable aid in the construction of the apparatus and Assistant-Professor Urban for the suggestion of the problem.

[2] L. R. Geissler. Am. J. of Psy. Vol. XX, page 487.

These two methods differ fundamentally in the way in which the subject's attitude is affected and a characterization of mental processes under different conditions may be obtained. In the first arrangement we require the subject to perform some particular operation and then interfere with that operation by another stimulus. The attitude of the subject is affected by a controllable stimulus. In the second case the attitude is directly affected, the subject is required to carry on two mental processes simultaneously and we may suppose that not only is the mental attitude of the subject different but also that the processes influence each other. Disregarding the complex nature of this interconnection we may consider the difference in the estimation of the weight under the normal and under the complicated conditions and speak of the influence of the distraction. It is this influence that we wish to investigate.

No attempt was made to measure the distraction but care was taken that it should remain constant throughout the experiment. The formulation of our problem, namely, the influence of a distraction on the formation of a judgment, does not require a definite measure of the distraction but only requires that no variation of it take place within the investigation.

DESCRIPTION OF THE APPARATUS

The Weights

The weights used in this experiment were hollow metal cylinders, two and one-half inches in diameter and one inch high, closed at one end. In their preparation they were all made slightly lighter than the lightest weight to be used in the series and then melted solder was poured into them to such an extent that each weight was just slightly heavier than it would be when used in the experiment. Then, in order to have them exactly accurate, a sufficient amount of the material was scraped out. In previous experiments the material used for this final adjustment was parafine but this is more susceptible to hygroscopic influences than the solder. The material used is the least subject to variation from the action of the weather, temperature, etc. So little was

it influenced that at a second weighing, of one half of the weights chosen in random order, made at the conclusion of the first series of 500 experiments, a variation of more than two milligrams was found in only one case and in the majority of the others a variation was not registered on the balance.

The weights being thus constant under the same conditions, these conditions must be kept constant. By using the same number of standard as comparison weights no weight is lifted more frequently than another. Thus a variation of temperature due to the contact of the warm hand is the same in every case. The absolute temperature of the weights is not such an important factor because our experiments only demand that the conditions be constant for each series of experiments. The influence of temperature could have been eliminated by using for the weights hard rubber which is near the physiological zero point. It is not, however, so anhygroscopic and the variations due to such influences are much greater than in the case of the metal. By keeping the temperature of the room the same the temperature of the metal weights is practically a constant and, therefore, a negligible factor. To sight and touch the weights were all the same, being identified by marks placed on the inner surface.

The weight chosen as a standard was 100 grams so that our choice of comparison weights was to a certain extent determined. To work with comparison stimuli that were always judged heavier or lighter than the standard might result in no influence of the distraction being shown while that influence might exist. That is, the subject might correctly judge the weight as heavier whose difference was 50 per cent greater than the standard even though there was a very strong distracting mental process. It was necessary then to find a series of comparison stimuli, the lowest and highest ones of which would not be correctly judged every time. Then it was necessary to be sure that the series used without distraction would be satisfactory for the experiment when distraction was present. A further limitation on our choice is made by the fact that for the determination of the psychometric function seven comparison stimuli are sufficient. The problem of selection is then confined to the distribution of these seven. This

was done empirically; weights ranging from 88 to 106 grs. with intervals of 3 grs. were tried but it was found that for Subject I alone, whose training on experiments with lifted weights was very extensive, was this series satisfactory. The other subjects required a series whose lightest weight was 84 grs. and the heaviest 108 grs. with 4 gr. intervals. Some objection might be raised to using two different series for the different subjects but as we describe our method of calculation, it will be seen that there is no serious objection to it.

The Table

The rotating table used by Dr. Urban in his experiments on lifted weights was the starting point of the development of the rest of the apparatus for this investigation. The rotating table has two great advantages. First, the space error which is very difficult to control is entirely eliminated. For the lifting of every weight the position of the subject's hand and arm is the same. Second, experimentation is made comparatively easy and the large amount of data necessary for statistical treatment can be obtained with a fair degree of speed. The size of the table, 56 inches in diameter, was determined by the number of weights to be used. Two series of experiments in each of which seven comparison stimuli were used, had to be arranged for. Thus 28 weights must be placed on the table, 14 of these being the standard weights and 14 the two series of comparison weights. They had to be placed at a sufficient distance from each other to preclude the possibility of the subject's hand touching two weights at the same time. Figure I represents a plan of the table and the accessory apparatus. Around the outer edge of the table the weights are placed, each weight occupying a section which on the circumference measures a trifle more than six inches. The weights on those sections designated by the odd numbers are the standards and those on the even numbered sections are the comparison weights. Of these weights those lifted when there was no distraction are on sections 2, 6, 10, etc., and those of the series with distraction are on 4, 8, 12, etc. On these sections the weights of a series are placed in irregular order.

The first series of experiments required the presentation of a continuous sound at the lifting of a weight. This sound stimulus might be given by the experimenter operating the apparatus for making the sounds, but two great difficulties would have to be overcome. The work of the experimenter is, without that additional task, sufficient to keep him employed and to require him to operate the sound apparatus might increase the difficulty beyond his ability. But even though the experimenter were able to do this there would be the greater objection that it would be impossible to have the two stimuli simultaneous. The experimenter could not present the distracting stimulus at the same time as the subject lifts the weight. It is more desirable to have the actual lifting of the weight actuate the sound apparatus. To arrange for this electrically is the most obvious way but the difficulty consisted in making a current by the lifting of a weight. To overcome the difficulty a relay was used. This relay in its primary position makes connection in the circuit of which the weights form a part and which is complete when all the weights are on the table. When a weight is lifted the relay completes the buzzer circuit and a sound is given. Part of the table circuit is formed by a series of wires underneath each weight. Commencing in section 1 a wire passes into section 2 where it ends. In section 2 a wire begins and passing into section 3 ends in the same relative position as the wire ended in section 2. In like manner the series of wires is arranged through each successive section until section 28 is reached. When all the weights are in position this part of the circuit is complete, the weights acting as switches between the various wires. The wire commencing in section 1 is connected with the electric battery and buzzer as follows: The buzzer, which in the cross-section part of the drawing is shown in a megaphone, is placed directly behind the subject and is connected with a battery and the relay. This relay, with a battery, is connected with contact rings placed on the base of the table. The contacts which slide along these rings are firmly fixed to the under surface of the table and connected by wires with the binding-posts shown at 1 and 28. From 1, on the under surface of the table, there runs a wire which at the outer edge of the

table passes up through it and connects with the wire beginning in section 1. The circuit is now connected with the series of wires on top of the table and the current passes directly through that series until it comes to section 28. From the end of the wire in that section, a wire, similar to that connecting binding-post 1 with section 1 and similar to the wire connecting each post with the corresponding section, passes underneath the table to post 28. From that post the current passes through the sliding contact and the contact ring to the relay. Thus, when all the weights are in position the circuit is complete, the relay forming a connecting link in it. The lifting of any weight breaks the circuit and the relay is brought in as the connecting link in the circuit for the buzzer. With this arrangement, at the lifting of any weight the buzzer would be actuated and the sound stimulus given. We wish, however, to present the distraction on certain specified weights, that is, on the comparison weights of one series. It is therefore necessary to arrange a contrivance by which at the lifting of the other weights the current is not broken. This is done in the following way. Instead of allowing the current to pass into section 1 we connect binding-post 1 with binding-post 4 thereby sending the current into section 4. Thus the current will not be broken at the lifting of any one of the weights 1, 2, or 3, the connection being made through the binding-posts. This arrangement is made throughout the entire circumference of the table and by a simple changing of the connection among the binding-posts we are able to eliminate the sound in whatever order we desire.

For the second group of experiments it was necessary to arrange a piece of apparatus that would give discrete sounds in any desired number and on any desired weight. The same kind of sound stimulus was used as in the first series, that is, an electric buzzer which had to give separate clicks. The arrangement is shown in Figure II, the lower part of which represents a section of the table, the buzzer and the battery; the upper part of which shows the apparatus for giving the sounds. The portion of the drawing marked "Elevation" shows a drum in cross-section. In this drum are six horizontal slits into which contact pieces fit. The first contact piece of each slit is shown on one side of the

drum. If this drum is rotated and the circuit of the buzzer completed through each separate contact at every contact a sound will be given, the number of sounds being equal to the number of contact pieces. The current of the buzzer enters the drum at A and leaves through the contacts B. Which one of the contacts it leaves through, and therefore the number of sounds that will be given, is determined by the experimenter who has beside him a selective switch which is inserted in the circuit of the buzzer. In order to set the drum in motion the current from the table was connected, in the same way as in the first arrangement, with the relay which completed a circuit for the strong electro-magnet as shown in the drawing. This magnet, when actuated, brings into play the friction gear which rotates the drum. The lines which are marked "to motor" represent belts that come from a continuously running motor. These belts turn the wheel of the friction gear which in its normal position runs free. As long as a weight is off the table, the relay is in the circuit of the electro-magnet and this keeps the friction gear in action. When the electro-magnet ceases to act a spring brings the friction wheel to its original place and the rotation of the contact drum ceases. But the drum must be brought back to its initial position, otherwise at the next lifting of a weight the drum might have to make almost a complete revolution before the first contact would be made. The introduction of another current was sufficient for this purpose. Contact C when the drum is at rest, touches the piece of hard rubber inserted in the metal ring that rotates on and with the axis of the drum, but which is insulated from the rest of the apparatus. Contact D is always in connection with this metal ring: These two contacts are connected with the electro-magnet and the battery. While the drum is at rest no current can pass through this circuit because of the break made by the rubber insertion. When the drum commences to rotate the rubber piece glides away from contact C and the circuit is complete. This current actuates the electro-magnet until the drum has made a complete revolution and contact C again rests upon the piece of hard rubber.

A very important factor is the presentation of the distracting

stimulus simultaneously with the stimulus to be judged. We do not see any way by which this could more accurately have been done than by the way used here. In order to determine exactly how far we had succeeded we measured the actual time elapsing, between the lifting of the weight and the first sound, by graphic registration. This was done for both groups of experiments by using two electro-magnetic time-markers. One was inserted in the primary or table circuit and was actuated when that circuit was complete. The other was inserted in the buzzer circuit, the marker being free while all the weights were on the table. Lifting a weight released the marker of the table circuit and a break in the line on the kymograph was registered. At the first sound the buzzer circuit was complete and the magnet of the time-marker in that circuit was actuated thus registering a break in the line which it made on the kymograph. We have now a record showing the amount of revolution of the kymograph between the lifting of the weight and the sound of the buzzer. In order to translate this amount of revolution into time units a tuning fork giving 100 vibrations per second was used. It made its record just above the records of the time-markers and by measuring the distance between the break of the two lines and counting the number of vibrations given by the tuning fork within that distance the time was determined. This measurement for the first arrangement gave in terms of σ 49.24 with a mean variation of 0.76 σ. The greatest variation was 1.24 σ, that is, the lowest time given was 48 σ and the highest was 50 σ. For the second arrangement the average time was 232.2 σ with a mean variation of 1.07 σ. The largest variation in this case was 2.42 σ. What we do in these measurements is, in the first case, to measure the latency of the magnet in the relay and in the second case to combine this with the time between the commencement of the rotation of the drum and the first contact. To one who did not see the apparatus working the second result might seem impossible. In the preparation of the apparatus I had not hoped to obtain such an accurate result but observation of the rotation showed that we had exceeded expectations. For such observations, numbering hundreds, the variations in distance from the point at which the

drum was expected to stop were so small as to be in most cases unnoticeable. The numerical result is then not surprising.

The entire apparatus was very reliable. The difficulty of making the electric connections by the weights was overcome by using several strands of a very fine wire instead of one heavier strand. The total number of stops for all causes during the entire investigation was very small. In the first part of the experiments it was never necessary to stop for more than a few moments. With the second arrangement, using the very complicated apparatus it was necessary to stop for the balance of the period on three different occasions but the few other stops were for very short times.

METHOD OF PROCEDURE

The experimenters were Subjects III and IV. While Subject IV acted as observer Subject III was experimenter. For Subjects I, II, and III Subject IV was experimenter. Their work, in the first group of experiments consisted in turning the table and recording the judgments. For the records we used prepared blanks in which the judgments on each comparison weight were recorded in one line. In addition to this, the experimenter, in the second series, had to operate the selective switch to produce the number of clicks desired and to record the number reported by the subject. The number of sounds given at any particular time was unknown to the subject but it was known that the number would not exceed 6, a limit which was set by the ability of the subjects to discriminate those sounds in the time allowed. Any particular number was given on every comparison weight the same number of times. To make this possible the experimenter made out slips which indicated the number of clicks for every comparison weight in any round of the table. These slips he followed in setting the selective switch. The position of the operator is shown at one side of the table in Figures I and II.

On the opposite side of the table is the position of the subject who is seated in a chair provided with an adjustable arm-rest. His hand extends beyond the arm-rest, through a screen which shuts off his view of the table, and is in a position to lift the

weight. The lifting of the weights is regulated by a metronome giving 92 beats a minute with a bell ringing every fourth beat. At the first beat, when the bell rings, the subject allows his hand to drop toward the table and grasps the weight, at the second beat he raises the weight, at the third beat he replaces it on the table and at the fourth beat he raises his hand. He is then in the same position as at the beginning of the experiment and is ready for the next lifting. The time between replacing the weight and the next downward movement is sufficient for the experimenter to turn the table and bring the next weight directly beneath the hand of the subject. Each subject was allowed to select the manner of lifting most convenient for the formation of his judgments. A considerable number of practice experiments, made before the beginning of those recorded, enabled him to find this out. The lifting was done by simply raising the hand at the wrist and no attempt was made to regulate the excursion of the hand. The judgments given were heavier, lighter or equal, the judgment always referring to the second weight of a pair. An essential point in this method is, that the subject never knows what intensity of weight is to be given. In order to make it impossible for him to know he was never told in what order the weights were placed on the table. In addition to this, at the end of every 150 experiments the order of the weights was changed so that he could not gain any information by the lifting. In the second series a statement of the number of clicks had to be given. The instructions given to the subject were that he should give the best possible judgments on the weights. This implied that he would be passive in regard to the sound in the first series but in the second series he was instructed to count the number of clicks as accurately as possible.

That the instructions were followed well we have proof in the agreement of objective evidence with the statement of the subjects. Each subject reported that his attitude in the first group of experiments was quite passive although Subjects II and III said that anticipation of the sound was probably an incentive to rapid judgment. That attention was given mostly to the weights and

that the subjects were for the most part passive to the sounds is shown by the fact that there were frequently at the beginning of a three-minute period a number of judgments made when the distraction should have been present but was not and at times none of the subjects would notice it until judgments had been given on every pair of weights on the table. This is evidence that the attention was given primarily to the judgment of the weight and the opposite result in the second part confirms this evidence. In that part all the subjects noticed the absence of the sounds even though they were omitted in only one case.

All the subjects had been well trained in laboratory experimentation but only one had been trained in experiments on lifted weights. None of the other three had done any work of this kind so it was necessary to make a long series of practice experiments before the subjects were qualified to carry on the regular work. The qualification necessary was that the subject become practically automatic in his liftings, that is, automatic to such an extent that it requires no effort to keep his movements in time with the beats of the metronome. The practice experiments for this purpose extended over six regular sessions and each subject made about 2000 preliminary judgments. When the second part of the experiments was begun each subject had to have three more practice sessions in order to learn to count the sounds at the same time that he lifted the weight.

In each session 30 judgments on every comparison weight were made. At the beginning of each session the subject lifted every weight on the table as a warming-up series as well as to put them in the right position relative to his hand. A session was divided into ten periods at the beginning of which a few experiments were made that were not recorded. These were simply for the purpose of allowing the subject to concentrate on his task. At the end of each period the subject rested approximately one and a half minutes and, the experiments of a period requiring between three and four minutes, a session lasted about an hour. Neither the experimenter nor the subject felt that period of time to be a great strain and this is a very important fact especially in reference to the subject. If he should find the work very difficult and

become weary toward the end of the hour we have different conditions under which the experiment is carried on and therefore our results at the beginning and at the end of the hour are not strictly comparable. It will be necessary to determine by exact mathematical calculations whether or not such a factor is to be considered, but for two reasons we do not believe it to be important. First, for two comparison weights the coefficient of divergence was calculated and was practically unity, thus indicating that the experiments were made under the same conditions during the entire hour. Second, for the first 500 judgments the number of heavier, lighter and equal judgments was counted for each of the ten periods of a session; that is, the sum of these judgments for the first period, for the second period and so on for each period of every day was calculated. These sums show that the proportion of different judgments given on the different comparison weights is practically the same in every period.

RESULTS AND METHOD OF TREATMENT

The data of the investigation were collected in groups or series of 50 judgments on each comparison weight. These series are given in Tables 1 to 24 in the appendix. In the first column of a table are given the numbers of the series. The other columns, taken in groups of three, contain the absolute frequencies of the judgments, heavier, lighter and equal on the various comparison weights. In all, there are recorded 61,600 judgments. This is exclusive of the judgments given in the practice experiments which numbered about 12,000. The complete investigation required, then about 75,000 judgments; a number sufficient to answer the questions raised in connection with this particular problem. These judgments are divided among the three arrangements that we used in the investigation. Tables 1 to 4 give the frequencies of the different classes of judgments in the first 10 series for each subject when the judgment was made without the distraction. In Tables 5 to 8 are the corresponding frequencies of the judgments for the first 10 series when the subject was distracted by the sound stimulus. Tables 9 to 16 give the results for the experiments with and without the count-

ing of the sounds in the six succeeding series of judgments. In these series the sound was presented simultaneously with the comparison weight. The next group of tables, from 17 to 24, contains the frequencies of the different classes of judgments for 300 experiments for each subject when the sounds were given simultaneously with the standard stimulus.

The results given in these different series, while not identical for the same comparison weight, are sufficiently consistent to be regarded as empirical determinations of probabilities. Because of this fact the results may be treated by the method of Constant Stimuli.[1] This method resolves itself into the determination of two quantities which are usually designated by the letters h and S, of which the latter refers to the difference threshold and the former to the measure of precision of judgment. S_1 refers to the lower threshold and S_2 to the upper threshold while h_1 and h_2, determining the rapidity of rise of the curves of the psychometric function, refer to the lighter and heavier judgments respectively. The results for every comparison stimulus furnish observation equations of the following type: $h(X - S) = \gamma(P)$, where X is the value of the comparison stimulus and γ (γ is the t of Titchener's terminology) the value given in the $\Phi(\gamma)$ formula. The values of X are given in the comparison weights used. The values γ are found in the fundamental table for the method of right and wrong cases (Urban p. 368). Each equation has a weight (P) which is given in the table of weights (Urban p. 371). If the number of comparison stimuli is greater than two the system of equations for the determination of the values h and S is over-determined, there being required only two equations for the determination of two unknowns. The most advantageous way of treating such an over-determined system, Urban has shown, is by the Method of Least Squares where the normal equations for the two values are as follows:

$$[X\,X\,P]\,h - [X\,P]\,C = [X\,P]$$
$$-[XP]h + [P]C = -[\gamma P]$$

[1] G. E. Muller; Gesichtspunkte und Tatsachen der psychologischen Methodik. E. B. Titchener; Quantitative Psychology. W. Wirth; Psychophysik. F. M. Urban; Die psychophysischen Massmethoden als Grundlagen empirischer Messungen; Archiv für die gesamte Psychologie XVI Bd.

The value C is used in the equation for the sake of simplicity, it really being the product of h and S of the observation equations. The use of the square brackets in these equations means that the sum of the products of these values is to be taken, that is, the sum for every observation equation. The values are the comparison weight X; γ, the value found in the fundamental table for the p, or probability, of the particular X; and P, the weight of the observation equation for that same X. The demonstration is based on the fact that the numbers of the relative frequencies of the different judgments under constant conditions have the character of empirical determinations of unknown probabilities. From this it follows that the errors in these determinations are given by Bernoulli's theorem, that is, that they are distributed according to the $\Phi(\gamma)$ function.

The setting up and the solution of the normal equations is not difficult but it must be arranged systematically because of the possibility of errors in the long computation involved. The amount of work is so great that the method of constant stimuli was for a long time an entirely impractical method. That we have been able to use it in this investigation is due to the method and tables furnished by Urban.[2] For this method it is only necessary that the intervals between the various comparison stimuli be the same. We then arbitrarily substitute the value 0 for the middle comparison weight and the values 1, 2, 3, etc., and —1, —2, —3, etc., for the comparison stimuli above and below this middle one. Our computations are thus reduced to the very simple ones of multiplying these small numbers and the corresponding values of γ and P. But the products to be added in the terms of the normal equations being once determined for each value of p (the n in the terminology of Titchener) are determined for all cases. These products Urban gives in the table of pages 240 and 241 of the article referred to. In forming our tables for the calculation of the values h and S it is necessary to transcribe the products for the various probabilities, compute their

[2] F. M. Urban; Hilfstabellen für die Konstanz Methode; Archiv für die gesamte Psychologie, Bd. XXIV.

sum and use these sums in the normal equations. The resulting h and S which we call h′ and S′ are not the value we would have gotten by the longer calculation. In order to determine the true values a very simple calculation is necessary. The value h′ is divided by the number of units between two successive comparison stimuli and the result is the true h. The value c is obtained by multiplying the value h by the comparison stimulus taken as zero and adding to the product the value c′. To show the actual amount of work required a sample table is here appended.

Solution of the Normal Equations for h and S. Subject I; Series II; With the Distraction; Lighter Judgments.

X	p	P	γP	XP	XXP	XγP
3	0.02	0.1881	0.2732	0.5644	1.6931	0.8195
2	0.02	0.1881	0.2732	0.3762	0.7525	0.5463
1	0.18	0.7327	0.4743	0.7327	0.7327	0.4743
0	0.46	0.9964	0.0707			
—1	0.60	0.9768	—0.1750	—0.9768	0.9768	0.1750
—2	0.78	0.8025	—0.4382	—1.6051	3.2102	0.8764
—3	0.94	0.3954	—0.4346	—1.1861	3.5582	1.3039
		4.2800	0.0436	—2.0947	10.9235	4.1954

	h 10.9235	+c 2.0947	=	4.1954
	h 2.0947	+c 4.2800	=	—0.0436
	h@	+c 4.3878	=	8.7881
h@		+c46.7526	=	—0.4763
		—c42.3648	=	9.2644
		c′	=	—0.2187
		h′	=	0.4261
		c	=	13.5553
		h	=	0.1420
		S	=	95.46

In the table, X is the comparison stimulus used in this auxiliary method of calculation; p is the probability, or the relative frequency, of the judgment; P is the coefficient of weight and γ is the value gotten in the fundamental table. The entire work of making out and computing one of these equations requires less than half an hour.

DISCUSSION OF RESULTS

Tables 33 to 44 in the appendix contain the results obtained by this method of calculation from the original data given in Tables 1 to 24. These tables are arranged in the same order of subjects and series. The first column of each table gives the number of the series. The columns designated by h_1 and h_2 contain the

coefficient of precision for the lighter and heavier judgments respectively. The columns containing the upper and lower thresholds are marked S_1 and S_2. The difference between these two thresholds is called the "interval of uncertainty" and is given in the column so marked. The last column contains the value designated "point of subjective equality." This quantity is defined by $\frac{c_1 + c_2}{h_1 + h_2}$ and closely approximates the average of S_1 and S_2 owing to the small difference between h_1 and h_2. With the exception of the first column, each is divided into two sections, one section marked with a minus and the other with a plus sign. These signs mean that the results given in the divisions so marked are for the series without and with the distraction. The last line in each table is the average of the results given in the corresponding columns.

In order to have a more direct comparison we have collected these final averages in separate tables. Table 49 contains the averages of the first ten series for each subject as well as a general average of the results for the four subjects. From the general average we find that the values h_1 and h_2 are greater in the series in which the sound stimulus was given than in the series in which there was no interference. In the same series the interval of uncertainty is smaller and the point of subjective equality is lower. The averages of the various subjects show practically the same fact as this general average. The h_1 with sound is in every case larger than the h_1 without the sound. The same thing is true in 3 cases of the h_2 while one case is negative. In the results of the individual series for the different subjects we find the following. Subject I (Table 33) has 19 results in which the h is larger in the series with the sound than in the series without it. That is, only one case does not conform to the general average. Subject II (Table 34) gives 13 results in which the h's in the series with the sound are greater and 7 where they are smaller. Subject III (Table 35) shows a similar result. In 15 cases the h with the sound is larger while in 5 cases the opposite holds. For Subject IV the cases are equally divided, 10 of the h's with sound

being larger and 10 smaller than the corresponding h without the sound.

The results with which we have been dealing are those of the first 500 experiments, that is, those in which a continuous sound was given on the comparison weight. It is interesting to compare directly with these the values of the h in the two arrangements of the second group. The averages of the subjects and the general average for these two arrangements are given in Tables 50 and 51. Table 50 contains the averages for the group with the distraction on the comparison weight. The general average of this table reveals the same fact as was pointed out in the discussion of Table 49. The h in each case is larger in the series with distraction. Six of the individual averages agree, while only two disagree, with the general average. The individual series of the subjects, as given in Tables 37 to 40, show a like correspondence with the general average. For Subject I there are nine cases of agreement and three of disagreement; for Subject II there are four results agreeing and eight disagreeing with the general avearge. For Subject III ten results show a like preponderance of the h with the sound, two show the opposite. Subject IV gives an equal division; six cases of agreement and six of disagreement with the general average.

In Table 51 we have these values for the 500 experiments in which the subject counted the sounds as they were given with the standard weight. In this group a similar result is found; h_1 and h_2 are larger in the general average of the series with the sound and the relation of the individual averages to the general average is similar to that of the previous series, but the distribution of the cases is somewhat different. There are seven cases of agreement and only one disagreement with the general average. In the individual series Subject I gives nine results that agree with the general average, two where there is disagreement and one case in which the h without the sound and the h with the sound are exactly the same. Subjects II and III give identical results; six cases for each have an h greater with the distraction than without. Subject IV has eight results agreeing and four disagreeing with the general average.

So far we have dealt only with the value h. Our next consideration is the interval of uncertainty. The general averages for the three groups given in Tables 49, 50 and 51 show the interval smaller in the series with distraction. The averages for the individual subjects agree in every case with the general average, that is, the interval of uncertainty in the series with the sound is smaller than in the other series. For the individual cases we find practically the same result. In series 1 to 10 the total, for the four subjects, of agreements with the general average is 33 and of disagreements only seven. In series 11 to 16 there are 18 cases where the interval in the distraction series is smaller and 6 where it is larger than the corresponding interval without the distraction. Series 17 to 22 give a like result; in 19 cases the interval is smaller and in 5 larger with the distraction.

The general averages of the point of subjective equality are different in the two series of the two groups. We find that in Table 49 the general average is smaller in the series with the sound. However, only two of the four subjects give results that agree with this general average. The individual series of the subjects are divided in a similar way. Subject I in each of the ten cases gives a lower point of subjective equality in the series with the sound. For Subject II there are seven results where the point is lower and three where it is higher. The results for Subject III are directly opposite to those of Subject I. In this case the point of subjective equality for all series with the sound is higher than for the corresponding series without the sound. In the results for subject IV there are only four cases where the lower point is registered in the series with the sound. The total of these cases for the four subjects is 21 that agree with the general average and 19 that disagree with it.

For the first part of the second arrangement the results are not so ambiguous. The general average, as given in Table 50, shows the same feature as the general average of the preceding group, that is, the point of subjective equality is lower for the series with the distraction. The averages for the individual subjects give three agreements with this general average while there is only one disagreement. The individual series of the

subjects show a corresponding preponderance of cases that agree with the general average. Subject I has the same number of agreements as disagreements. The results for Subject II are quite the opposite of the general average, giving only one case in six that agrees with it. Subjects III and IV give results that correspond to the general average, the former giving six cases that agree, the latter five that agree and only one that disagrees. In the total for the subjects there are fifteen results that agree with the general average and nine that disagree.

The general averages of the point of subjective equality in the two series of the other part of the second arrangement are practically identical. The averages for the individual subjects give, as would be expected, two agreements and two disagreements with this general average. Of the individual cases for the various subjects we have the same thing to relate. Thirteen of the cases agree with this general average and 11 disagree.

A clearer expression of the results may be gotten in the curves of the *psychometric functions* for the different arrangements. These curves, given in Charts 1-12, are plotted from the results of the various groups of experiments. That is, Charts 1-4 are plotted from the results of the first 500 experiments for each subject, Charts 5-8 from the experiments with discrete sounds on the comparison weight and Charts 9-12 from the experiments with the sounds on the standard weight. These curves give the value of the calculated p, or probability, for each value of the comparison stimulus. The calculated values of the probabilities are not identical with the observed values but Urban[1] has shown that the values of p in the $\Phi(\gamma)$ formula by which these curves are calculated agree most closely with the observed values. The calculation by which is determined the points of a curve which correspond to the comparison stimuli, is simply the solution for p in the following equation: $p = \frac{1}{2}[1 + \Phi(\gamma)]$. The value of γ we get in the observation equations for each comparison weight and the value $\Phi(\gamma)$ we get in Bruns'[2] table for the $\Phi(\gamma)$ function.

[1] F. M. Urban; Psychophysischen Massmethoden als Grundlagen empirischer Messungen.

[2] H. Bruns; Wahrscheinlichkeitsrechnung und Kollektivmasslehre.

The full lines in these charts are the curves of the psychometric function for the series without the distraction. The broken lines are the curves for the series with distraction. In sixteen cases the latter curve ends nearer unity than the former, in four cases the two curves end at the same point, and in four the curve for the series without distraction is higher. These facts are in strict accord with the statements in reference to the mathematical results. The interval of uncertainty which includes the comparison stimuli on which the p for the lighter and heavier judgments does not exceed the value ½, is in nine cases clearly smaller for the distraction series. The points of subjective equality, the points of intersection of the curves for the lighter and heavier judgments, given in these curves likewise correspond to the results of the mathematical calculations. For the first group of experiments, in two cases the point is nearer the lightest comparison weight, and in two cases nearer the heaviest comparison weight for the distraction series. In the second group three of the curves of the distraction series are shifted toward the left, while one is further to the right, that is, in the direction of the heavier comparison weights. The results of the third group show points further to the left in two cases, further to the right in one and one case where the points for the two series practically coincide.

Briefly summarizing these results: the coefficient of precision is larger for the judgments in the series accompanied by a distraction; the corresponding interval of uncertainty is smaller. The point of subjective equality is lower in the series where the distraction was given simultaneously wiith the comparison weight. but in the series with the distraction on the standard weight it is the same as in the series free from distraction.

With such results we must now ask the reason for them; and we take first the values of the h and the interval of uncertainty. For both these the result is a contradiction of what we expect. The h is a measure of precision of judgment and instead of it decreasing when we have a distraction, it shows quite a marked increase. We would expect that the effect of a distraction would be to decrease the ability to form a correct judgment although

Titchener[3] says "It has been shown, experimentally, that we attend best under a slight distraction; maximal clearness requires a little 'effort', as we say, for its attainment." It seems that in the result of our experiments we have a proof of this statement. The judgment that is made when the mental process is interfered with by other factors is more accurate than one made when there is not such a distraction. On the other hand, it is quite possible that a very short length of time is required for a correct judgment of these comparison stimuli and that the first impressions are most reliable for the formation of a judgment. Thus the sound distraction, rather than being a distraction or interfering with the primary processes of judgment simply compels a greater rapidity of work. In other words, distraction does not mean that we carry on our work in a more satisfactory way, it simply means in this case that the subject is compelled in a short time to give a judgment on the basis of elements which would be neglected if a longer time were allowed for the judgment. In support of this statement we may refer to the series of experiments carried on by Dr. Urban[4] in which he deals with the equality judgments (page 99). In this series of experiments the subjects were required to guess whether the weights which they had judged as equal were heavier or lighter. The guesses were, in a majority of the cases, a correct estimation of the relative intensity of the weights. Then, as Dr. Urban says (page 100), "There exists therefore more than an even probability that a guess judgment will be correct. This seems to indicate that the subject in giving a judgment on the equality of two stimuli is liable to overlook certain data of the sensation which would be sufficient to decide his judgment." In our experiments no guess judgments were allowed, but the same principle is involved as in the investigation reported by Dr. Urban. "The data of the sensation sufficient to decide his judgment" were not prominent in consciousness but the "guess" judgment was based on these. If, however, a record of the equality judgments had been kept

[3] E. B. Titchener; The Psychology of Feeling and Attention, page 203.

[4] F. M. Urban; The Application of Statistical Methods to the Problems of Psychophysics.

and at the conclusion of an hour's work the subject had been required to guess, his judgments would most likely have been as often wrong as right. In other words the elements on which the judgment was based disappeared. Instead of requiring the subject to guess we had an experimental arrangement that compelled the same kind of judgment. The distraction compelled the subjects to decide, before these factors were neglected, what judgment they would give.

The problem whether or not the greater precision of judgment is due to central or peripheral factors is here met. Our conclusion is that the explanation is to be found in the central factors. In other words the sensations upon which judgments are given are the same in the series with the sound as in the series without the sound. The influencing factor, then, must be found in the attitude with which the subject faces his problem. Although the subjects reported generally that in the first arrangement they were not prepared for the sound, it came at such regular intervals, that it seems most likely that the subjects were aware when the distraction would be given. This does not contradict the statement (on p. 13) that the subjects paid attention primarily to the judging of the weights and were passive to the sounds. The fact that they did not miss the sound in the first of a period shows that it had not a prominent part in consciousness but when the experiment was in progress we are quite sure that the subjects were conscious that the sound would be given. Being aware of it, their attitude was that of giving a judgment as quickly as possible and so allowing as little time as possible for the distraction to influence the judgment. We are reminded in this connection of the statement by Fechner that "Grey paper is not brighter the harder we look at it." Although the statement may be in a certain sense true we are not prepared to admit all that it seems to imply. We do not believe that the grey paper is not clearer in consciousness when we look harder at it. In other words, while the sensations may remain the same, their relative value in consciousness changes. The grey paper, as we look at it, becomes a prominent factor in consciousness. In the same way, the sensations produced in lifting the weight become more prominent factors in conscious-

ness when the subject is prepared by the thought of the distraction than when he experiments in the ordinary attitude. We have then a solution of our results in terms of psychical factors, that is, in terms of attention. The subject when compelled for a brief time to give the greatest amount of attention to the judgment makes more consistent judgments than when experimenting without that brief maximal effort.

The problem presented by the decrease in the size of the interval of uncertainty is a very interesting one. This interval which gives the limits of the comparison stimuli on which the probability of a heaver and lighter judgment does not exceed ½, is a direct measure of the sensitivity of the subject. When there is a decrease in the interval it means there is an increase in sensitivity. We may connect this fact with the one previously mentioned, namely, that when a short time is allowed for the judgments the accuracy increases and the explanation is fundamentally the same as the explanation of the increase in the value h. Part of this increase in accuracy is seen in the smaller number of equality judgments given and the interval of uncertainty is directly proportional to the number of equality judgments. The area of the curve of the psychometric function for the equality judgments is equal to an area determined by the size of the interval of uncertainty. This interval, giving a measure of the sensitivity of the subject, is the distance between the points 0.5 on the curves for the lighter and heavier judgments. Constructing a rectangle, with lines passing through these points perpendicular to the abscissae as sides and the zero and unit abscissae as the two ends, we have an area equal to the area of the curve of the equality judgments. Decrease the number of equality judgments and the interval of uncertainty decreases. So our explanation of this decrease is based on the fact that a heavier or a lighter judgment is given in cases where an equality judgment would be given if the subject had more time for the formation of a judgment. The formation of a judgment rapidly due to the distraction accounts for the smaller interval of uncertainty.

The question of the point of subjective equality is one where we come in direct contact with the problem of the increase or

decrease of sensation due to distraction. We have our answer to the question whether or not distraction has any influence on the intensity of sensations. This point of subjective equality gives the weight which is subjectively equal to the standard weight. If in the two series of experiments this value were the same, we would say that there had been no more influence on the judgments than that already mentioned. But the fact is that this point of subjective equality is not the same for the two series of experiments except in one arrangement. The general averages for the first arrangement are, as given in Table 49, 97.38 and 96.99; the latter being the point of subjective equality for the series in which the sound distraction was given. Our conclusion is, that there has been an overestimation of the weight caused by the distraction. Our conclusion from this general average is not in agreement with the statement given by Titchener,[5] "It is clear, then, that strong as well as weak sounds are intensified by attention, or, if you prefer the negative statement, are reduced in intensity by distraction."

Strong support for our conclusion is not given in the results for the individual series but for this fact we think we have a satisfactory explanation. Subjects I and II give results that agree quite markedly with the general average. Subjects III and IV give opposite results. The total of the cases of these two subjects which disagree with the general average is 16, while in only 4 cases is there an agreement with the general average. This result, we believe, is due to the conditions under which the experiments were carried on. It was impossible to make arrangements for these experiments at any other time than late in the evening when both subjects had become somewhat fatigued with the day's work. We believe that it is this condition that makes the total of agreements and disagreements of the individual series with the general average so nearly alike. Further evidence for this conclusion we have in the results gotten in the second arrangement during which Subjects III and IV experimented in the early part of the day. We find that, in that arrangement, the outcome

[5] E. B. Titchener; The Psychology of Feeling and Attention, page 218.

corresponds closely to the outcome for Subjects I and II. In view of these facts we must conclude that the distraction causes an overestimation of the second weight.

A comparison of the results given in the three different arrangements reveals some interesting features. In the three arrangements the h is larger in the series with distraction than in the other; and the interval of uncertainty is smaller. It is the point of subjective equality that reveals the most interesting fact. In the first two arrangements this is quite noticeably lower in the series with the sound; but in arrangement 3 the results for the two series are practically identical. The reason for this may be found in a memory image of the standard weight. In arrangement 3 the sound distraction was present on the standard stimulus and of this standard stimulus, which was lifted a great number of times, a general memory had been built up so that the distraction on it would not increase its intensity as it apparently has done in the case of the comparison weights for which no such general memory could be postulated. One difficulty to be faced in this explanation is that the coefficient of precision shows the same phenomenon in this third arrangement. But the difficulty is not insurmountable because of two facts, one of which is that the judgments are made under similar conditions as in the first two series and the other is the fact which we mention in the following paragraph in reference to the influence of the distraction on the judgments made when no distraction was present.

No attempt was made in our investigation to determine whether or not the distraction persists and influences the judgments even when it is not present. This might have been done by making a series of experiments at a different time when no distraction would be given, the results being compared with the results of the series without distraction in these experiments. Some information on the question may be gotten by a comparison of the results obtained by Subject I in this investigation with results gotten by the same subject in an investigation[6] carried on in the early part of the year 1912. The results of this earlier investi-

[6] S. W. Fernberger; Comparison of Method of Constant Stimuli and Method of Just Perceptible Differences.

gation were calculated in series of 50 judgments on each comparison weight so as to be directly comparable to the results in this investigation. The results are given in Table 52. In the first line is indicated the value given in the corresponding columns; the second line gives the year of the investigation. In the third horizontal space are the results referred to in the first column as series. Series 1 gives the average result of the first ten series of 1912 and the first ten series of 1913 without the distraction. Series 2 is the average of series 11 to 16 for both years. Series 3 is a like result for series 17 to 22. The last line gives an average of these three series. This average shows that the measure of precision is greater for the year 1913. The three series give 5 out of 6 results greater for the same year than for the preceding. It is not to be supposed that it is due to the greater practice of the subject for this subject had carried on too large a number of experiments for such a great change in this comparatively short time. Rather is the difference to be accounted for by the presence of the distraction in the related series with distraction. This distraction not only causes a more rapid judgment on the weights with which it is given but also on the other weights. This explanation is consistent with the explanation given in regard to the size of the h. In the large number of experiments made the subject forms the judgment rapidly many times when the distraction is not given and the result is a greater number of lighter and heavier judgments. It is only reasonable to assume that that influence would be shown more markedly on the pair where the distraction is present even though it be on the standard weight, than in the judgment on the pair with which there is no distraction. Had we found no influence of the distraction in the series carried on simultaneously with distraction series our conclusions would still hold. When there has been an influence, but that influence has been to lessen the difference on which we based our conclusions, our position is made even more tenable.

We have stated that the lowering of the point of subjective equality in the series when a distraction is given is due to the distraction. That is, when there is a decrease of attention, we have, instead of a decrease, an increase, in the prominence of

the sensations. But the query is raised whether this phenomenon could not be just as well explained by a particular "form of attention." In a criticism of some experiments reported by Münsterberg[7] Miss Hamlin[8] states that his results were due to "expectant attention." The subject was prepared for a stimulus of greater intensity and the consequence was that he underestimated the stimulus given. This criticism seems to imply that there is in the attitude of the subject some factor similar to the factor producing the size-weight illusion. Instead of visual perception being the determining factor in this experiment there was a certain adjustment of the organs involved in lifting the weights. The muscles of the hand and arm are inervated in preparation for a smaller weight than that which is really lifted. It is necessary that it should be a smaller weight because the second weight is judged heavier in this series with distraction than in the ordinary normal series. It is not then an expectation of a greater weight but an expectation of a smaller weight that would lead to this difference in the position of the point of subjective equality. With such an explanation we cannot be very well satisfied when we consider the conditions under which the experiments were conducted. We have shown (see p. 13) that the subject never knew what intensity of weight he would lift and it is essential that he know this if there is to be the same adjustment of the arm and hand muscles relative to the weight lifted.

Another explanation of the difference is given in terms of adaptation. The subject having lifted one weight adjusts his hand for the lifting of a certain weight. This adjustment is so made that an overestimation of the second weight results. In this way the time error might be explained and the greater overestimation of the second weight in the distraction series is due to a greater adaptation of the hand and arm muscles. To this explanation we have one very serious objection. It is that the greater adaptation does not hold for the lighter weights of the series. More lighter judgments are given on the light weights in the distraction than in the normal series. This is shown in the

[7] H. Münsterberg; Psychological Review, vol. I, page 39 ff.
[8] Alice J. Hamlin; American Journal of Psychology, vol. VIII, page 66.

curves of the psychometric functions (Charts 1-12). In eight cases out of twelve the curve for the lighter judgments in the distraction series begins higher than the curve for the other series. If the adaptation explanation were valid this would not be true for we would have a regular overestimation of all the weights corresponding to the constant overestimation which we call the time error.

COUNTING NUMBERS

We now wish to determine the accuracy with which the various subjects counted the sounds given in the second part of our investigation. The reason for the determination is to give an answer to the question whether or not there was a second reliable mental operation being carried on by the subject. It might be that the subject gave all attention to the judgment of the weights, his count of the sounds being very unreliable. This would be shown by the number of errors in the counts. These errors are given in Table 53. In the first column the subjects are arranged in the order of their accuracy in counting. The numbers in the first line refer to the number of sounds given. In the columns corresponding to each of these numbers is recorded the number of errors made by the various subjects on those numbers. The last column gives the total errors for each subject and the last line the sum of the errors on each number. The greatest number of errors is recorded for the times when the subject was supposed to count 6. Four and five were incorrectly counted quite frequently but the difference in the ratio of errors on four and five and the ratio for five and six is quite marked. If each sound had been given under the same conditions we would not expect this result. Six, however, had an advantage over the others in that the subjects knew that there would never be more than six and therefore in that case they never made errors of over-estimation.

Of the subjects, Subject III makes the fewest number of mistakes. Subject IV has a little more than one half the number of errors made by Subject II. Subject I makes a few less than Subject II. The question, whether or not Subject III gave greater attention to the counting than the other subjects, has to be

answered. For this Subject the relative number of mistakes in counting is 1 in 191 cases, that is, in the total number of experiments the subject had to count 4200 times and he made errors in only 22 of these. Subject I in the same number of experiments made 332 errors or a proportion of 1 in 13. Subjects II and IV made 1 in 11 and 1 in 20 respectively.

The difference is very marked and the question is, is the difference to be explained by a different distribution of attention. If there were no other facts to which we could appeal we might be forced to conclude that Subject III had given more attention to the sounds than the other subjects. But, not only is the accuracy of his judgments on the weights quite comparable to that of the other subjects, there are other facts which lead us to believe that the difference in accuracy of counting does not mean a different distribution of attention. These other facts are; differing sensitivity of the different subjects to sound stimuli; previous practice in sound experiments, and the specific practice of this experiment. The influence of practice in this experiment is shown in the numbers of Table 54 which gives the number of errors for each subject in each series of 50 experiments. In the first column the subjects are referred to and in the succeeding columns are the number of errors for each subject in the 12 series in which the discrete sounds were given. The last line gives the total for all the subjects. These numbers show a decrease from the first series to the last. The numbers in the early series are very large compared to the numbers in the later series; the total in the first six series being 599 and of the last six only 352 or about 68.7 per cent; and the number in the last two series is only about one-fourth the number in the first two series.

But if practice in this experiment were the only factor the counting of Subject IV should be the most accurate for he had practice as subject or experimenter throughout the investigation That he is less accurate than Subject III who had practice during only one half of the investigation is due to the previous practice in sound experiments and greater sensitivity of Subject III. This subject had carried on extensive investigations with sound stimuli whereas Subject IV had carried on very few. Moreover

actual test showed that Subject IV was less sensitive to differences in sounds. This previous practice and keener sensitivity enabled Subject III to reach his maximal efficiency in the preliminary experiments and he shows no decrease in the number of errors during the series. The improvement of Subject IV is greater than that of Subject I and II although in the first series, after the practice of the preliminary experiments, he still shows as high a proportion of errors as they do. The explanation of the latter fact, we believe, is to be found in the greater sensitivity of these two subjects while the explanation of the former is to be found in the greater practice of Subject IV in this investigation.

THE INFLUENCE OF THE DIFFERENT NUMBERS OF SOUNDS

In both arrangements of the second group of our experiments the subject was required to count sounds which might be any number from 1 to 6. Three hundred judgments with every pair of weights were taken when these sounds were given on the standard and three hundred when they were given on the comparison weight. Every number of sounds having been given on the same comparison weight the same number of times, in both groups there are 50 judgments on each pair of weights with each one of these different numbers of sounds. We may ask, then, whether the counting of one sound had the same, or a different, influence as the counting of six sounds. One might suppose that the effort varied with the number of sounds to be counted and the variation would show itself in different degrees of accuracy in judging the weights. To answer the question we collected from our original data the different judgments given with these different numbers of sounds. The absolute frequencies thus obtained are given in Tables 25 to 32. These tables are constructed in the same manner as the tables in which are the absolute frequencies of the experiments taken in regular order. The first column contains the number of sounds that were given on each comparison weight. At the head of the columns the comparison weights are found, each column containing the frequencies of the different classes of judgments. In the last line of a

table is given the sum of these judgments for the six series. These data may be treated by the Method of Constant Stimuli and the values of h and S obtained in these calculations are found in Tables 45 to 48. The first column of these tables contains the number of sounds given on the different comparison weights. The divided columns marked h, S, etc., contain these values for the different series when the sounds were given on the standard and on the comparison weights. These numbers do not seem to show any regularity but before we are certain of this we must calculate the coefficient of correlation of the value h and the number of sounds given. On the basis of our present information, that is, on the basis of inspection of the values, we may conclude that the number of sounds to be counted has no influence on the judgment of the weight.

From these numbers, however, we are permitted to draw an important conclusion. If we calculated the coefficient of divergence for the six series of each of the groups with the discrete sounds we would be able to say very definitely that the judgments on each comparison stimulus were or were not given consistently. Lacking that coefficient we have a reliable index of the fundamental regularity of the judgments in the average result of the series taken in regular order and the average result in the series for the different number of sounds. The averages in these two cases are given in the last line of Tables 37-44 and 45-48. In the columns marked "sounds on C S" (comparison stimulus) of Tables 45-48, we find the averages which must be compared with the averages for the distraction series in Tables 37-40. The columns marked "sounds on S S" (standard stimulus) contain the averages which must be compared with the averages for the distraction series in Tables 41-44. The averages in both these cases are practically identical and from this fact the conclusion may be drawn that a fundamental regularity in the judgments existed throughout a group of experiments. This conclusion is possible because of the fact that the γ of an average of relative frequencies is not necessarily equal to the average of the γ's of the relative frequencies. If these two results are approximately equal we conclude that the original relative fre-

quencies must have been nearly identical. Such is the result in this investigation and we see that the order in which the judgments are taken does not influence the result. Series may be taken in the order in which they are made or the series may be composed of every other judgment or every sixth judgment as in this case and the results are practically the same. There exists then a fundamental regularity throughout a group of experiments.

CONCLUSION

We wish to show the bearing of the results in this investigation on the distinction between voluntary and involuntary attention. This distinction is made on the basis of introspective evidence. In the case of voluntary attention the custom has been to speak of an activity of the mind, whereas in the case of involuntary attention no such activity could be postulated. This distinction is mentioned by Külpe[1] where he says "Another current distinction makes attention voluntary and involuntary according as the will does or does not participate in its direction upon particular contents." This participation of the will is apparently what Kulpe means in the statement (page 425) "We have a general judgment of the origin of attention, in its description as an internal activity, concentrated in various degrees upon the particular ideas in consciousness. For this description only applies to attention, as given to introspection, on the assumption that we are able to perceive the internal activity as such. And this would mean, in its turn, that we are conscious of an internal activity above and beyond the contents upon which it is concentrated, and above and beyond the concomitant sensations to which its functioning gives rise." It is the presence of this internal activity as evidenced by introspection that distinguishes voluntary from involuntary attention.

In more recent works we see a different trend of thought. Wundt[2] says "If we apprehend an impression which is given to us without our assistance, the attention seems in a sense to be

[1] O. Külpe, Outlines of Psychology, page 427.

[2] Wilhelm Wundt, Introduction to Psychology, 1911, page 67 [Trans.—R. Pinter].

compelled to turn to this impression, following this single motive. We can express this by saying we apprehend it passively. The feeling of activity always follows such an impression. If on the other hand we turn to an expected impression, then these feelings of strain and excitation clearly precede the impression. We are aware that our apperception is active. These have often been called processes of involuntary and voluntary attention. But these expressions are unsuitable since in reality volitional processes are present in both cases. They are, like impulsive and voluntary acts merely processes of different grades." A similar view is offered by Pillsbury;[3] "We must in a large measure abandon the old systems of classification. There can be very little meaning given to passive and active, sensorial and intellectual, voluntary and involuntary attention. Classified from the standpoint of the conditions, we have only the more objectively conconditioned attention and the more subjectively conditioned—attention which depends upon the strength or size of the external object and attention which depends upon interest or the mental condition at the moment."

Whether or not the recent thought is more satisfactory we shall not attempt to say at the present time nor shall we attempt to refute or uphold the division of attention on the basis of introspection. We would, however, indicate the new method of approach to the problem that we followed in our experiments. The conditions for the two groups of experiments were arranged to produce states of mind which were introspectively different. In the first group the distraction was produced by a sensory stimulation without a concomitant mental activity otherwise induced. In the second group the work of counting the clicks was a prominent feature of the mental process involved. The question was, whether this introspective difference had the same or a different influence on the estimation of the weights. The only way to answer this question is to observe the relative frequencies of the different judgments. We may illustrate the differences existing in the following way. Suppose we have two urns, the colors of which are different and which contain unknown

[3] W. B. Pillsbury, Attention, 1908, page 311.

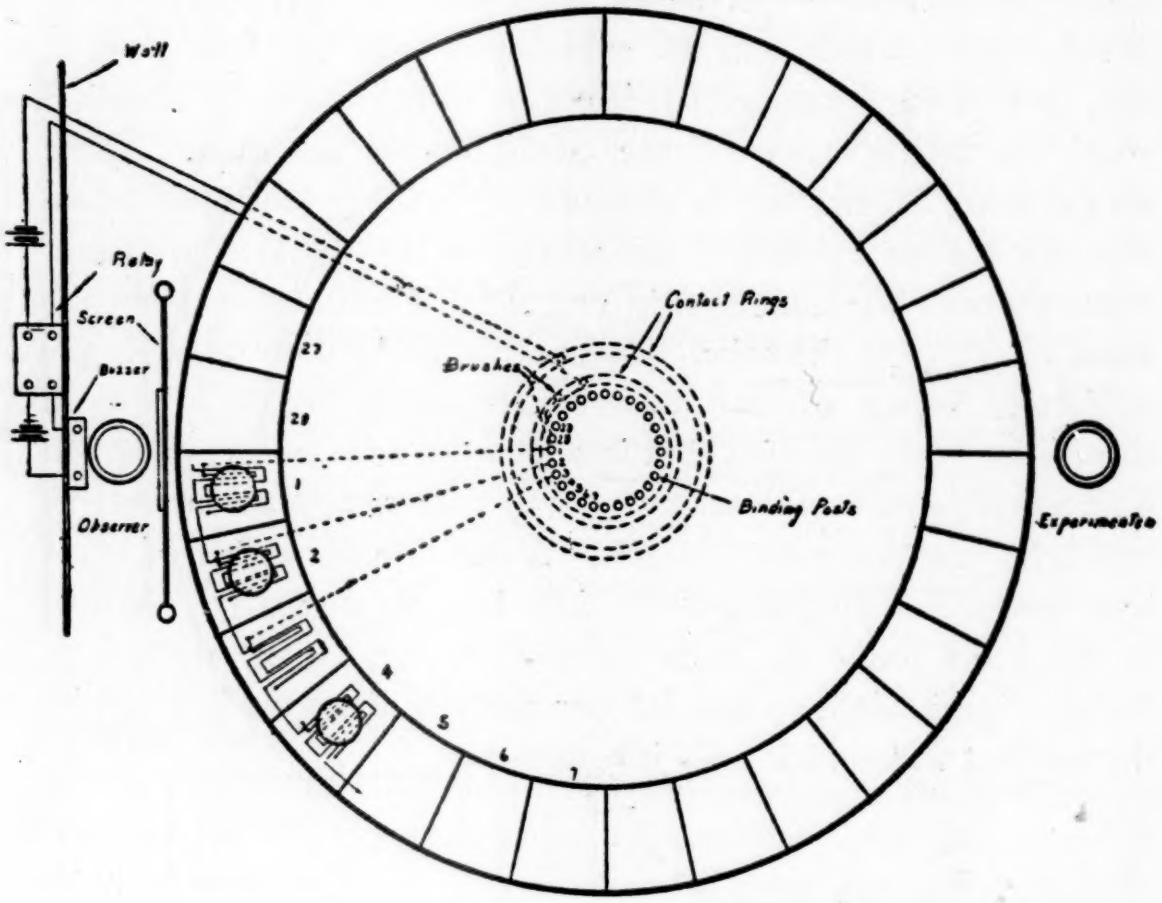
numbers of differently colored balls. We wish to determine whether the relative frequencies or probabilities in the drawing of balls of a certain color are the same or different for the two urns. For this purpose we draw a number of balls from each urn, replacing the ball when the color is recorded. Obviously the contents of the urns remain the same and represent a constant group of conditions. If in a large number of drawings the results obtained from the two urns are the same, our conclusion is that the contents of the two urns are the same. Now the two differently colored urns correspond to two mental states which are introspectively different. The drawing of the ball of a certain color corresponds to the passing of a certain judgment. The psychophysical nature of the subject and the objective experimental arrangement are conditions which doubtlessly do not have the same high constancy as the contents of the urns but which nevertheless show a sufficient degree of stability to make possible a statistical investigation.

The results of this statistical investigation are practically identical for the two groups of experiments. For this fact we offer the same explanation as in the case of the two urns. On the basis of like relative frequencies in the drawings of a certain colored ball we conclude that the contents of the urns were the same. Likewise, on the basis of similar outcomes for the judgments when we have a voluntary and involuntary direction of attention we conclude that the conditions must be the same. This conclusion, however, is based on the statistical results alone and we may ask a further question,—why is it that mental states which to introspection are so widely different, give like results? Our statistical investigation can give no answer, at present, to the question. But, the facts of introspection are likewise unable to offer any solution; these facts are simply that such differences do exist.

For an explanation it is necessary to go behind the facts obtained by introspection and this statistical investigation,[4] and

[4] See F. M. Urban, The Application of Statistical Methods to the Problems of Psychophysics, page 19—for a discussion of the different groups of causes underlying statistical results.

for this purpose more experimentation and further analysis is absolutely necessary. At present there seem to be two hypotheses either one of which may be satisfactory. In the first place it may be that our introspection is not an introspection of attention itself but introspection of the conditions of attention. These conditioning factors may be different while the processes of attention are the same whether voluntarily or involuntarily initiated. Thus we have the same system or group of causes to explain the same result. On the other hand, introspection may give us the subjective aspect of two different processes which are quite diverse and very complex, but in which the differences succeed in counteracting each other in such a way as to neutralize themselves and bring about identical results. A decision for either of these hypotheses can at the present time be only tentative. Which of them will prove the more satisfactory may be determined by future experimentation and further analysis along the line and by the method followed in this investigation.


Wall
Relay
Screen
Buzzer
Observer
Contact Rings
Brushes
Binding Posts
Experimenter
23
20
1
2
4
5
6
7

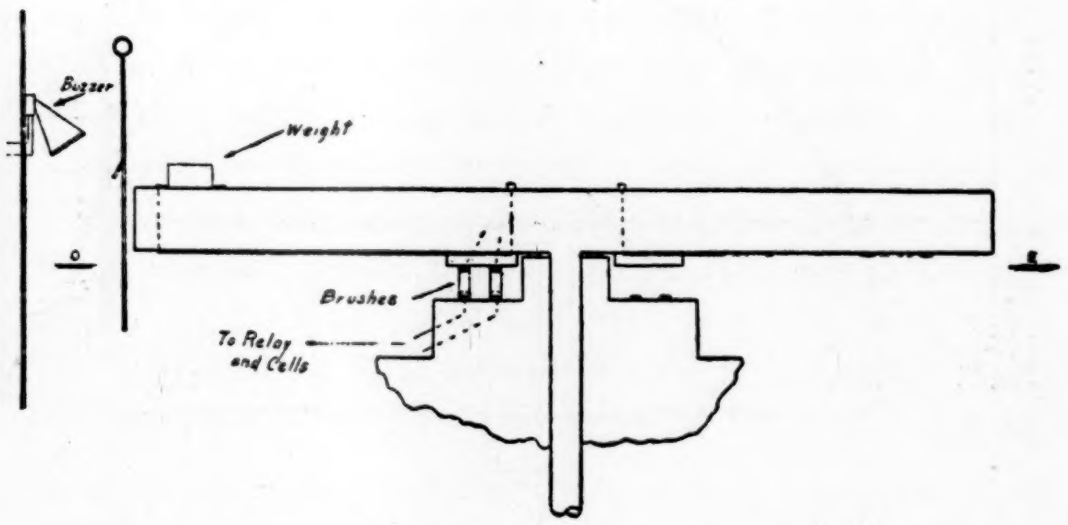

Buzzer
Weight
Brushes
To Relay
and Cells

FIGURE I

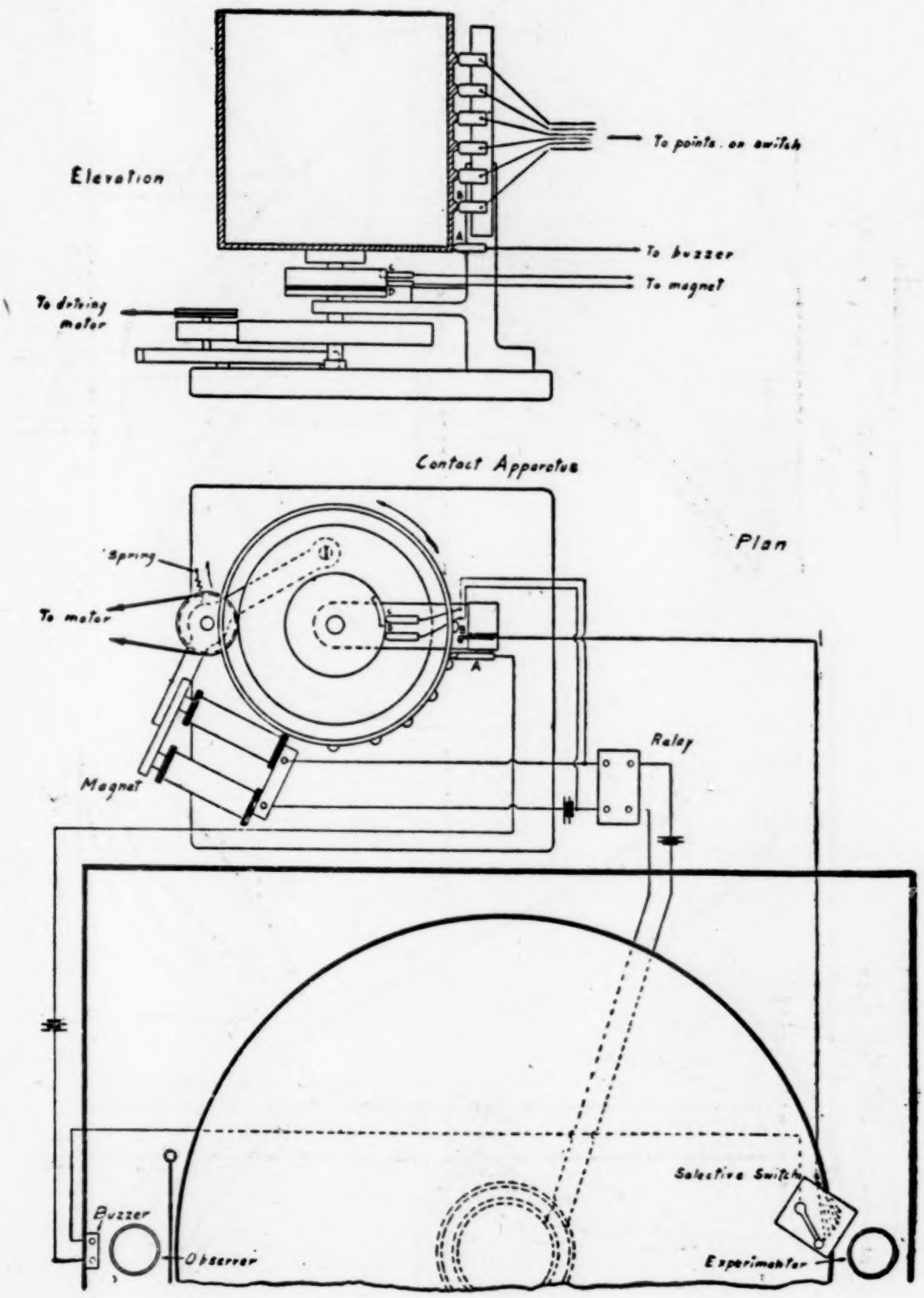
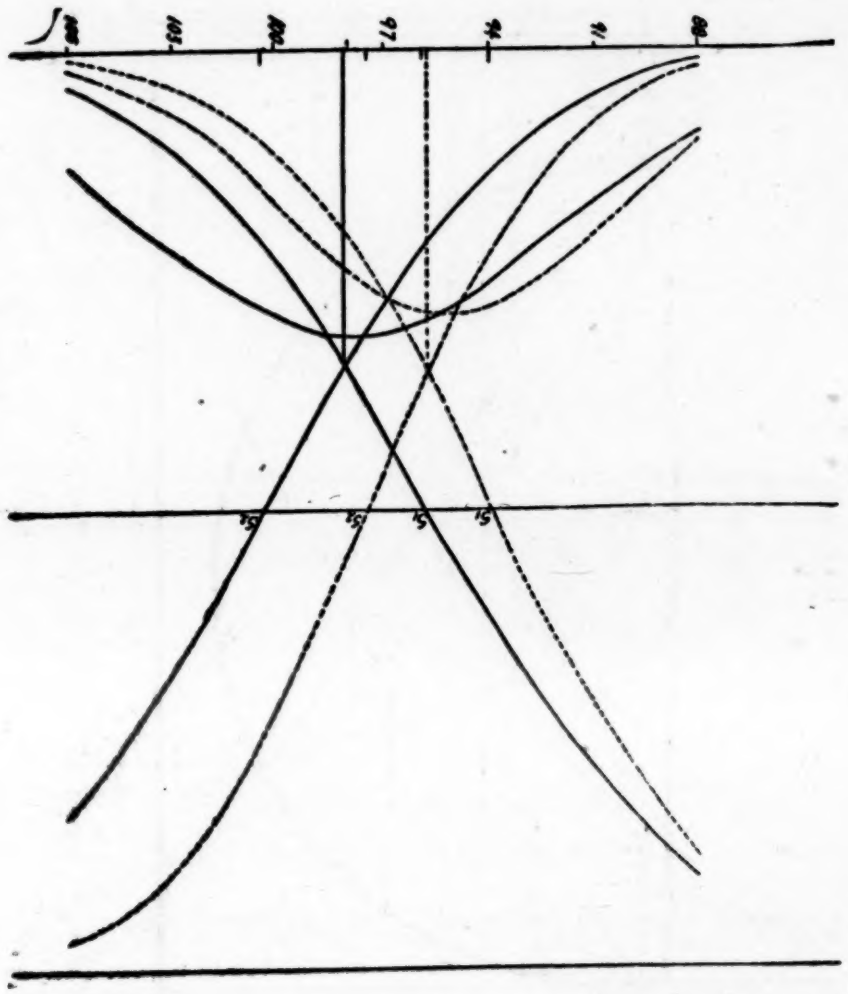
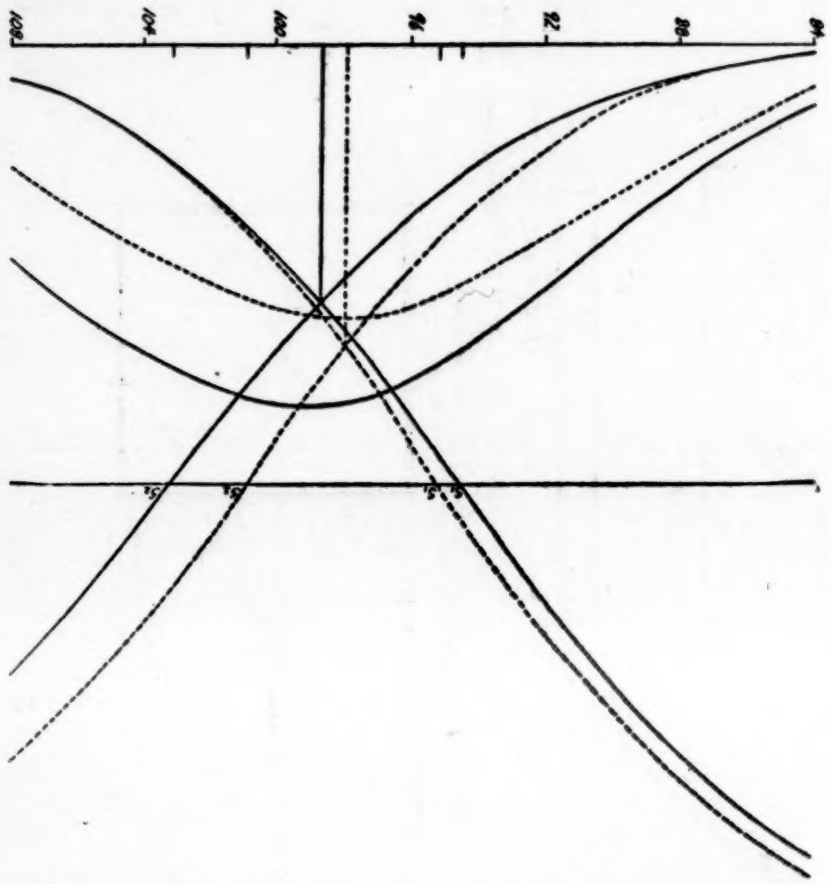

Elevation
To points on switch
To buzzer
To magnet
To driving motor
Contact Apparatus
Plan
Spring
To motor
Relay
Magnet
Buzzer
Observer
Selective Switch
Experimenter

FIGURE II



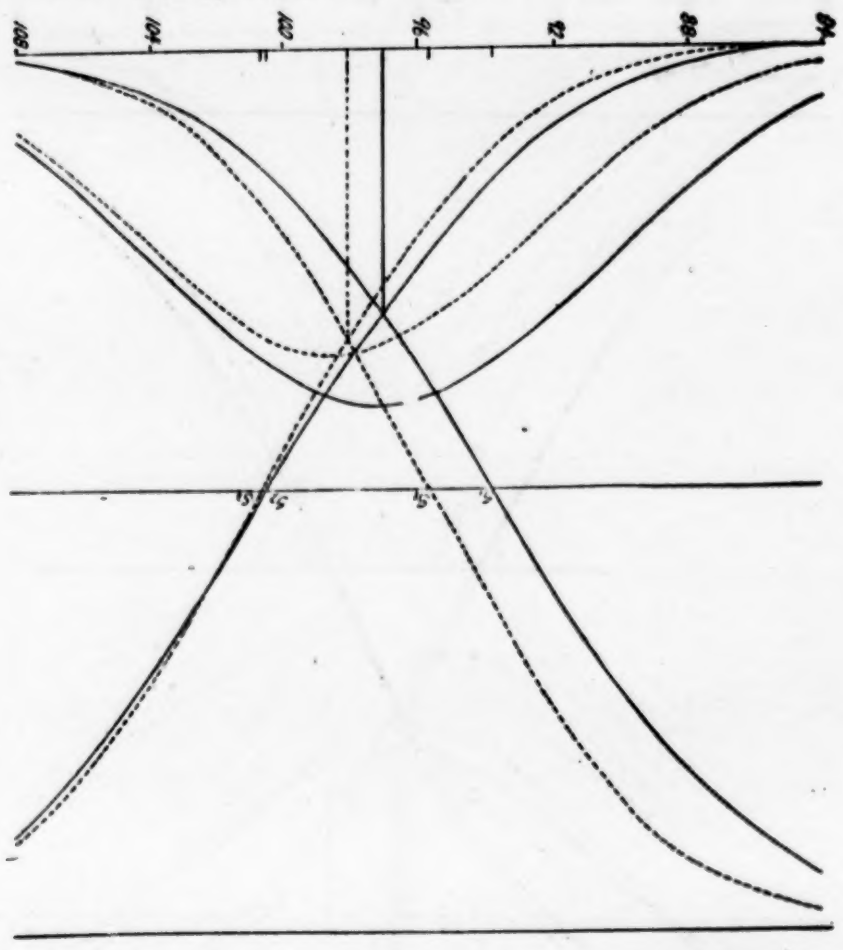
Subject I.
Series (1-10)

Chart 1



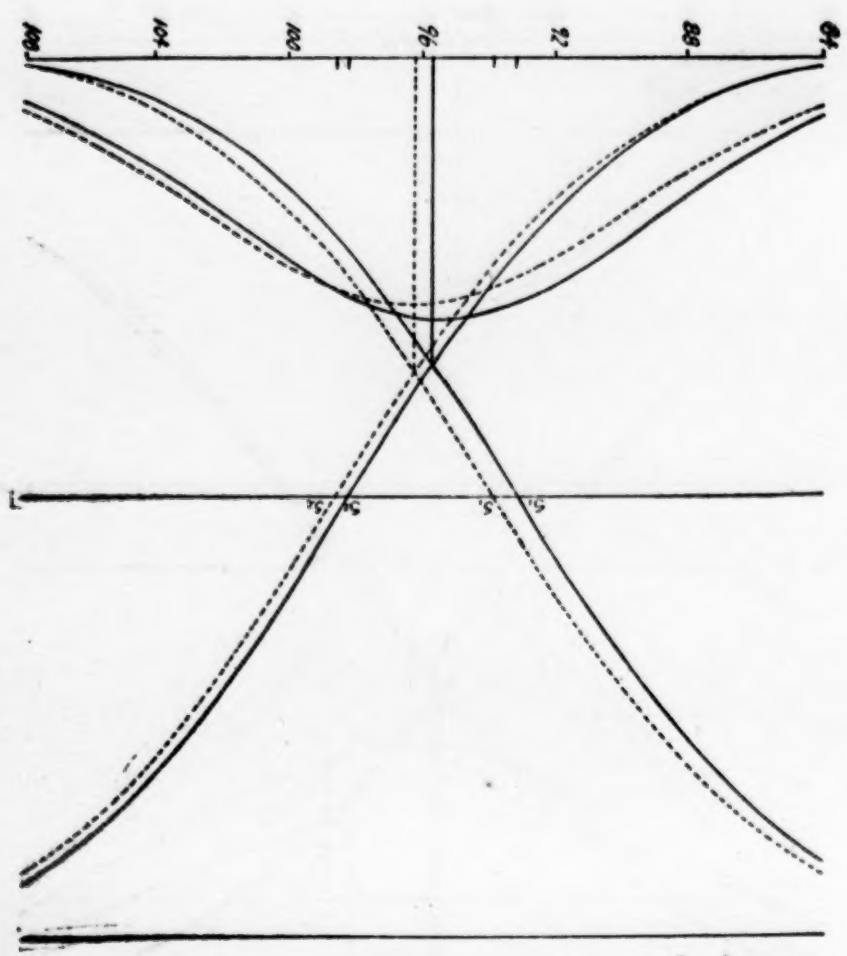
Subject II.
Series (1-10)

Chart 2.



Subject III
Series (1-10)

Chart 3.



Subject III
Series (1-10).

Chart 4

Chart 5.

Subject I.
Series (11-16).

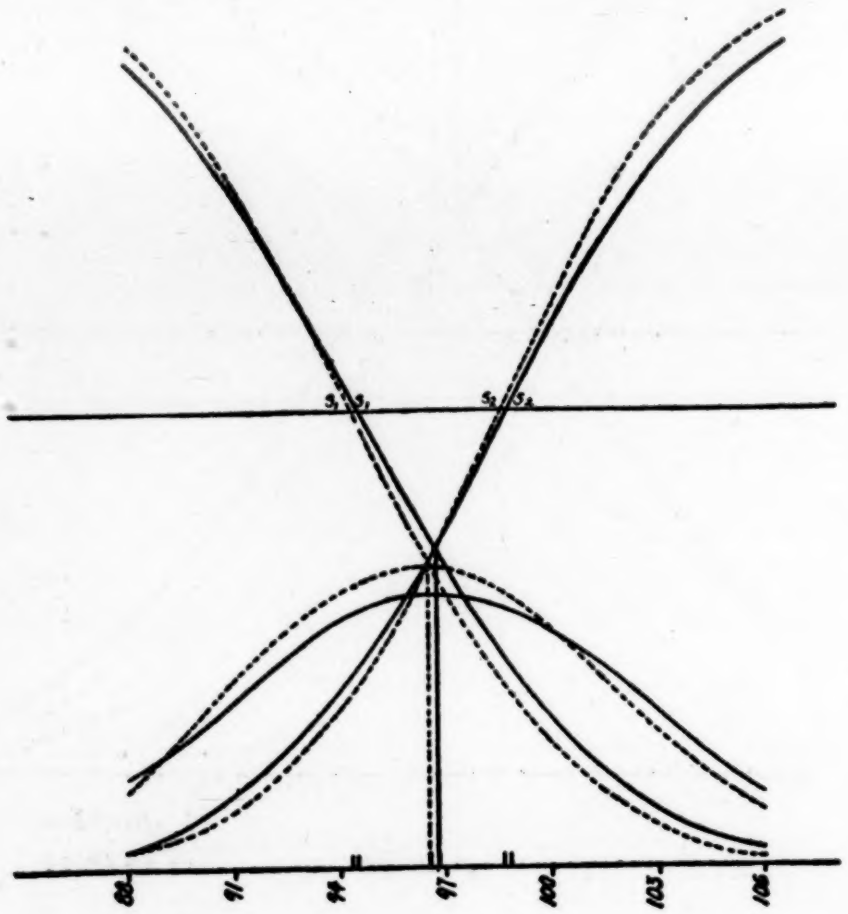
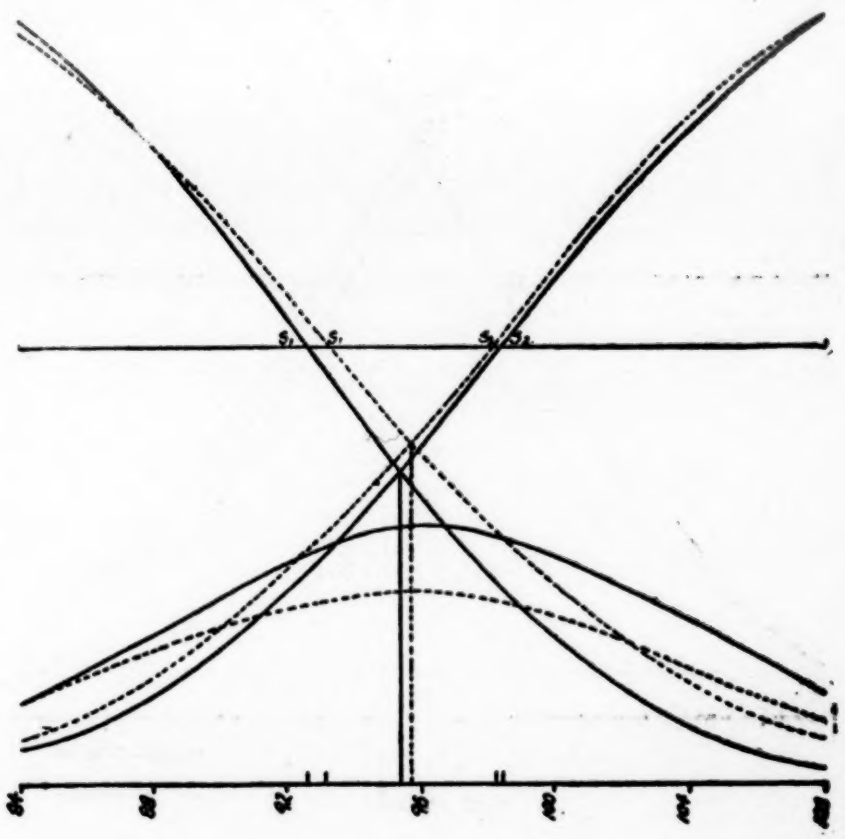


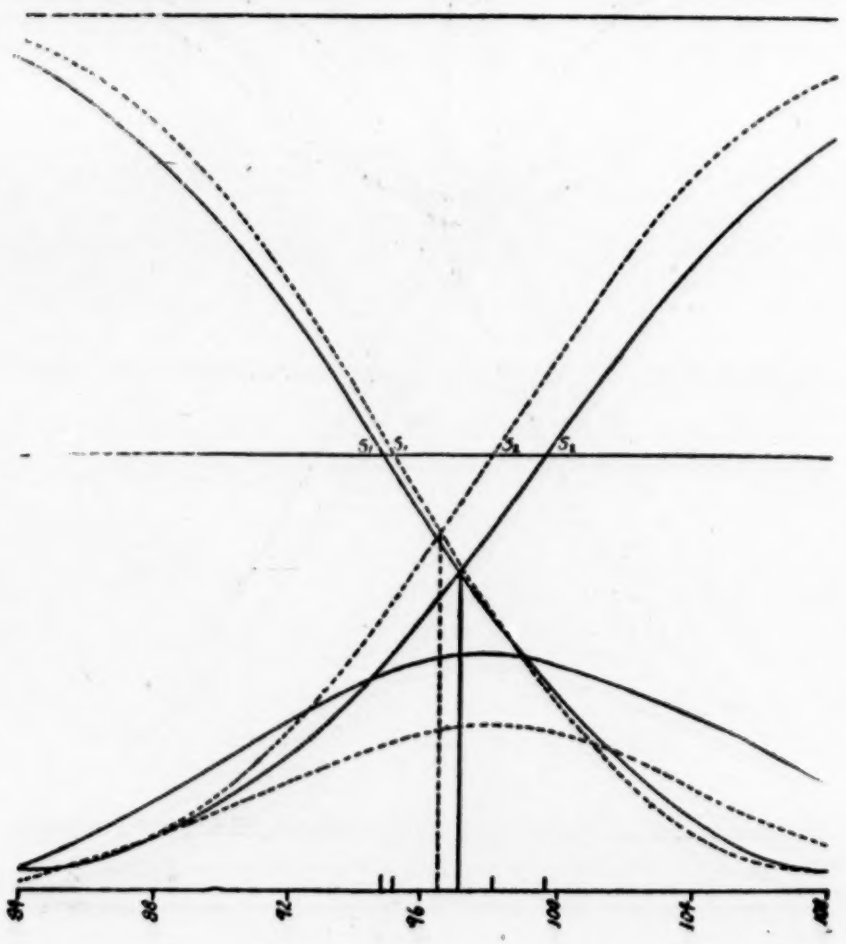
Chart 6.

Subject II
Series (11-16)



Subject III
Series (11-16).

Chart 7.



Subject IV.
Series (11-16).

Chart 8.

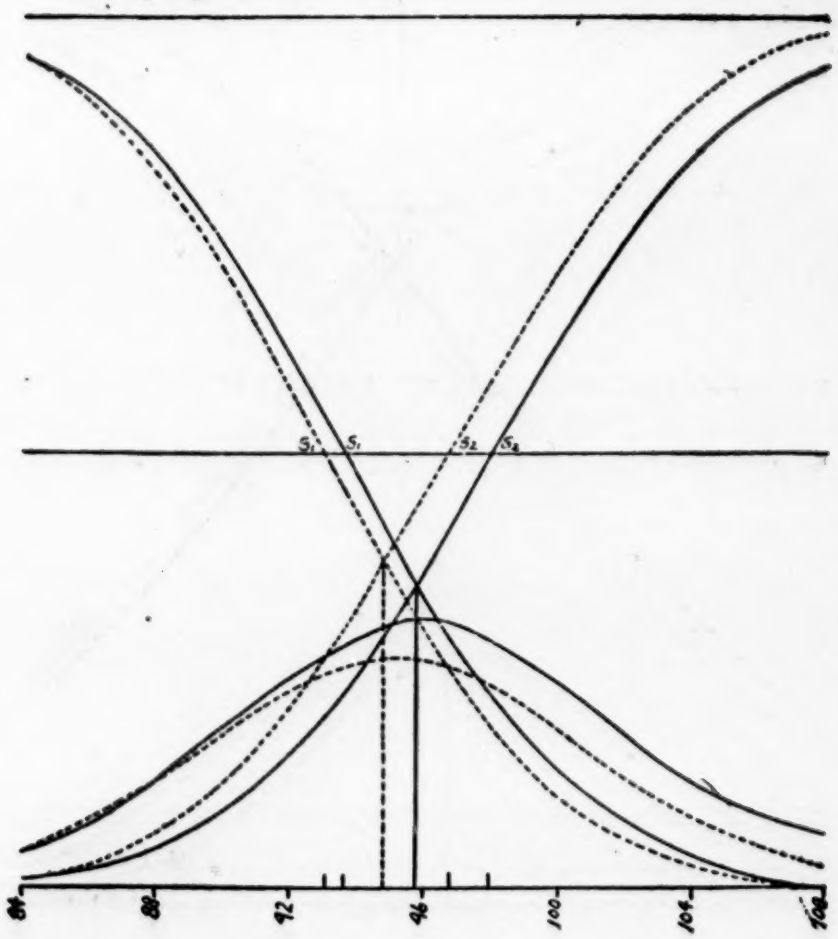


Chart 9.

Subject I.
Series (17-22)

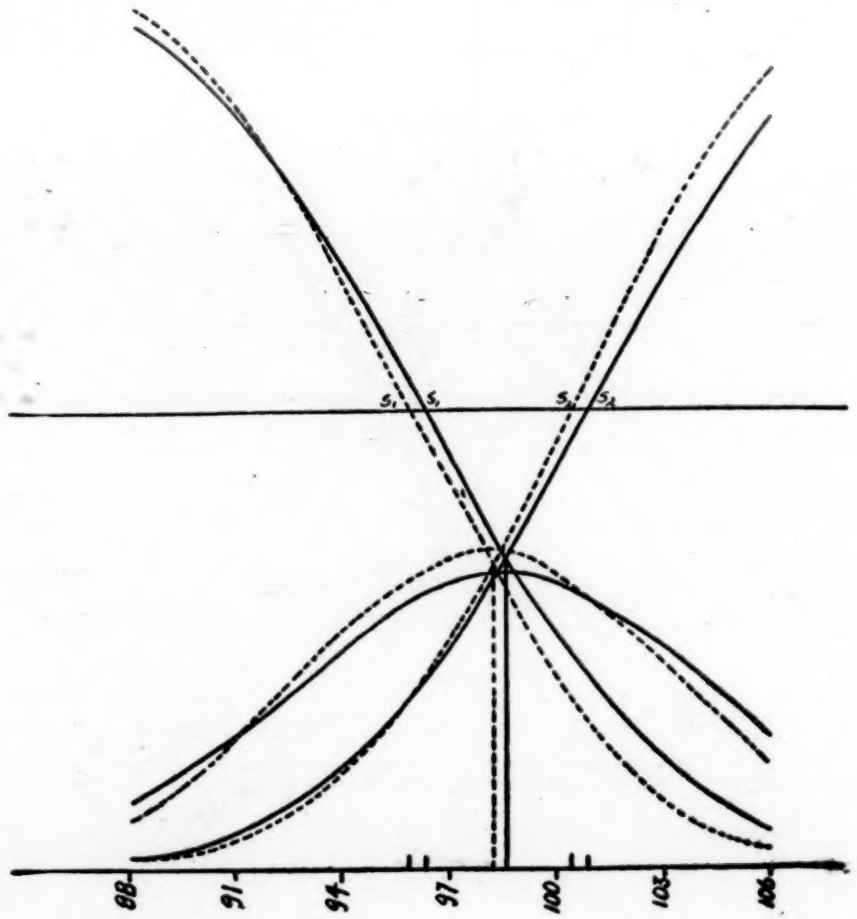


Chart 10

Subject II
Series (17-22)

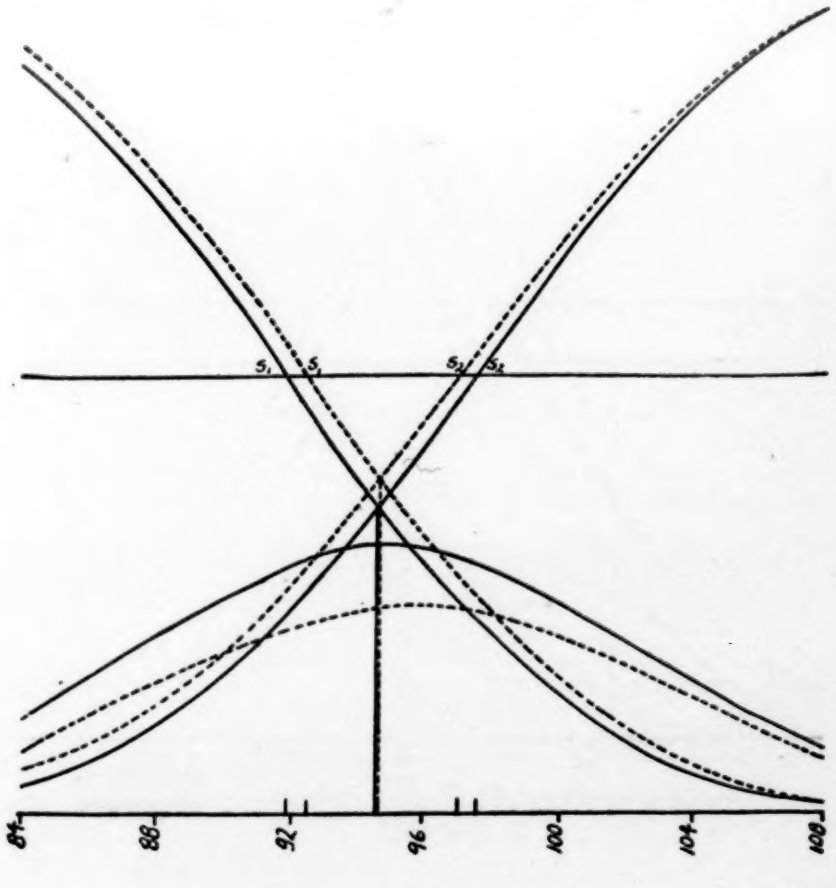


Chart 11.

Subject III
Series (17-22)

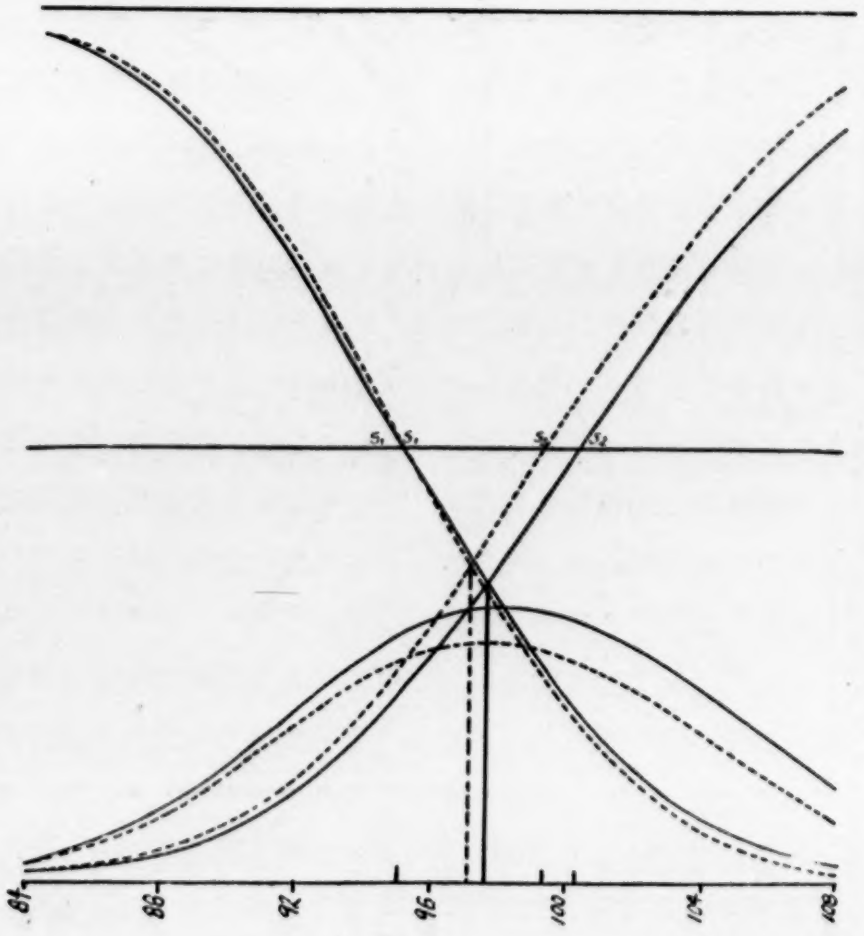
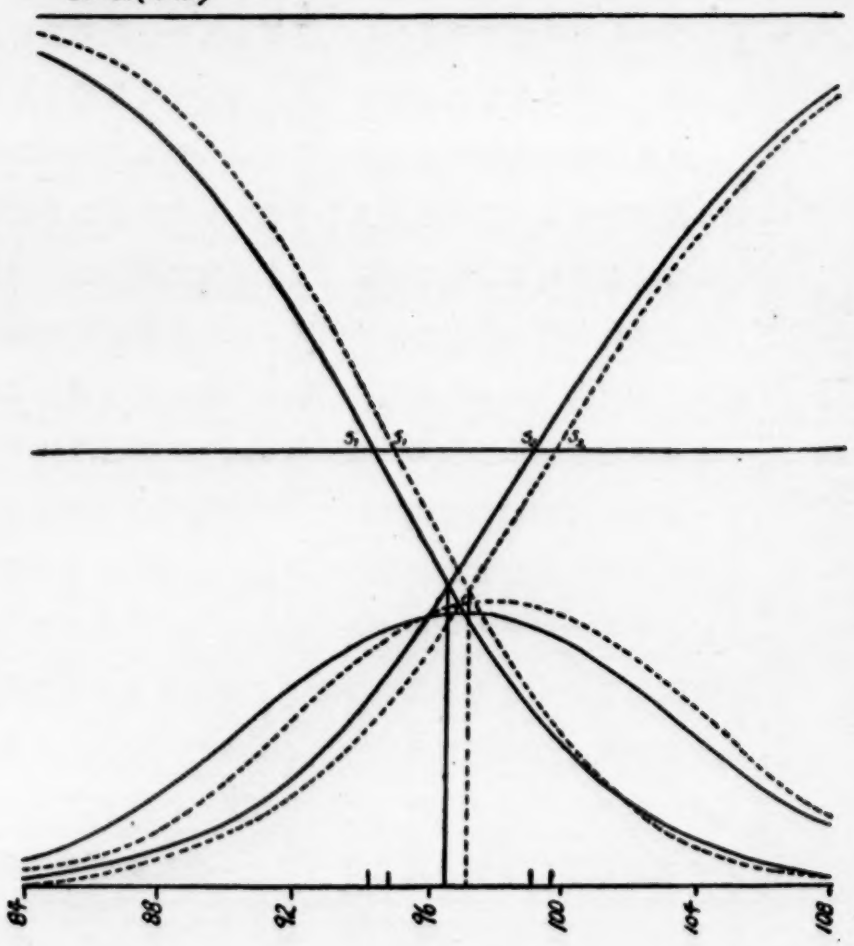


Chart 12.

Subject IV.
Series (17-22)



APPENDIX

TABLE I—*Frequencies of Different Classes of Judgment—Without Sound—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		6	44		12	38	4	16	30	18	15	17	23	13	14	34	13	3	41	5	4
2	1	5	44	2	7	41	3	12	35	16	14	20	29	9	12	32	9	9	42	6	2
3		3	47	2	8	40	7	7	36	12	21	17	21	17	12	31	10	9	47	3	
4	2	4	44		11	39	5	16	29	19	19	12	22	12	16	31	13	6	41	2	7
5	1	2	47	3	11	36	5	12	33	22	15	13	31	12	7	34	8	8	44	4	2
6		3	47	3	6	41	5	12	33	16	15	19	35	3	12	29	13	8	48	2	
7		5	45	1	7	42	5	12	33	11	24	15	27	17	6	41	5	4	39	7	4
8		3	47		5	45	9	17	24	13	18	19	26	19	5	35	9	6	37	10	3
9		4	46	2	9	39	3	14	33	9	20	21	23	16	11	34	10	6	36	11	3
10		1	49		9	41	4	15	31	7	21	22	21	16	13	28	17	5	36	14	
Σ	4	36	460	13	85	402	50	133	317	143	182	175	258	134	108	329	107	64	411	64	25

TABLE 2—*Frequencies of Different Classes of Judgment—Without Sound—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		7	43		7	43	5	19	26	7	28	15	26	17	7	23	21	6	40	9	1
2	2	1	47		4	46	7	17	26	8	16	26	21	24	5	26	17	7	42	5	3
3		2	48	1	8	41	3	8	39	6	22	22	19	21	10	21	17	12	40	9	1
4		4	46	1	7	42	3	14	33	11	19	20	20	21	9	27	16	7	36	13	1
5	1	6	43	2	3	45	4	22	24	8	19	23	14	27	9	25	19	6	42	4	4
6	2	4	44	1	9	40	4	10	36	5	21	24	12	29	9	19	19	12	30	17	3
7		2	48		4	46	6	11	33	7	20	23	12	15	23	21	25	4	29	15	6
8	1	2	47	5	5	40	2	23	25	11	15	24	23	18	9	22	23	5	25	24	1
9	1	3	46	3	10	37	8	15	27	9	15	26	24	21	5	35	11	4	41	6	3
10		4	46	3	11	36	7	18	25	17	19	14	33	14	3	38	8	4	47	3	
Σ	7	35	458	16	68	416	49	157	294	89	194	217	204	207	89	257	176	67	372	105	23

TABLE 3—*Frequencies of the Different Classes of Judgment—Without Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	9	40	2	13	35	4	19	27	10	27	13	18	23	9	22	25	3	40	9	1
2		2	48	1	9	40	2	28	20	5	27	18	19	28	3	27	20	3	44	4	2
3		5	45	2	7	41	1	22	27	9	21	20	23	24	3	26	22	2	41	8	1
4		7	43		9	41	4	15	31	6	24	20	30	19	1	23	26	1	43	5	2
5		4	46		7	43	1	16	33	9	24	17	28	21	1	33	15	2	45	4	1
6		4	46	1	2	47	2	10	38	9	16	25	28	20	2	26	13	11	44	3	3
7		1	49		4	46	9	14	27	19	6	25	27	12	11	39	8	3	47	2	1
8			50	1	1	48	5	14	31	16	14	20	28	10	12	38	8	4	48	2	
9	1	1	48	1		49	9	8	33	19	14	17	34	10	6	43	4	3	47	3	
10			50		5	45	7	19	24	18	16	16	36	11	3	43	5	2	49	1	
Σ	2	33	465	8	57	435	44	165	291	120	189	191	271	178	51	320	146	34	448	41	11

TABLE 4—*Frequencies of the Different Classes of Judgment—Without Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		2	48	4	15	31	8	15	27	17	24	9	32	12	6	36	13	1	39	7	4
2	2	8	40	4	11	35	4	18	28	13	21	16	33	16	1	38	9	3	47	2	1
3	2	1	47	2	13	35	5	19	26	15	21	14	40	10		40	8	2	45	3	2
4		3	47	3	7	40	9	8	33	19	15	16	21	19	10	44	5	1	46	3	1
5		3	47		6	44	4	7	39	18	17	15	34	7	9	40	7	3	48	2	
6	1	2	47	3	7	40	4	8	38	23	17	10	35	11	4	48		2	49	1	
7	1	1	48		4	46	8	13	29	17	16	17	30	11	9	46	2	2	45	2	3
8		1	49	2	14	34	8	12	30	18	14	18	37	7	6	46	3	1	49	1	
9		4	46		6	44	11	13	26	17	20	13	39	10	1	43	3	4	47	1	2
10		2	48	4	13	33	9	7	34	18	11	21	38	7	5	36	11	3	50		
Σ	6	27	467	22	96	382	70	120	310	175	176	149	339	110	51	417	61	22	465	22	13

TABLE 5—*Frequencies of the Different Classes of Judgment—With Sound—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		2	48	1	11	38	13	11	26	23	11	16	34	4	12	49	1		48	2	
2		1	49	2	9	39	14	13	23	17	16	17	37	9	4	44	2	4	48	2	
3	1	7	42	2	9	39	12	19	19	27	13	10	42	6	2	48	1	1	49	1	
4	2	3	45	1	5	44	11	19	20	23	15	12	33	9	8	45	4	1	47	2	1
5	1	9	40	4	4	42	16	14	20	20	19	11	36	8	6	43	6	1	46	3	1
6	2	6	42	4	7	39	14	16	20	23	10	17	37	5	8	41	8	1	45	4	1
7	3	7	40	4	10	36	9	16	25	22	17	11	44	4	2	43	5	2	50		
8	2	4	44	4	10	36	8	16	26	18	15	17	42	7	1	47	1	2	50		
9	1	6	43	5	11	34	4	18	28	21	15	14	36	8	6	46	1	3	49		1
10	1	7	42	3	8	39	8	17	25	28	12	10	36	10	4	43	7		48	2	
Σ	13	52	435	30	84	386	109	159	232	222	143	135	377	70	53	449	36	15	480	16	4

TABLE 6—*Frequencies of Different Classes of Judgment—With Sound—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	1	48	3	12	35	10	7	33	15	18	17	28	14	8	44	2	4	48	2	
2	2		48	1	4	45	8	13	29	12	18	20	25	17	8	30	13	7	45	3	2
3		1	49	1	3	46	6	11	33	18	9	23	23	14	13	29	16	5	44	5	1
4		3	47		8	42	2	19	29	14	11	25	27	12	11	32	12	6	39	8	3
5		1	49	2	6	42	5	13	32	7	14	29	23	17	10	34	14	2	42	5	3
6	1	5	44		8	42	5	11	34	12	17	21	21	21	8	30	9	11	43	5	2
7		2	48	1	8	41	6	9	35	3	16	31	27	13	10	28	16	6	39	8	3
8	1	2	47		5	45	5	8	37	13	15	22	21	19	10	27	13	10	34	7	9
9		3	47	2	9	39	4	13	33	12	14	24	23	18	9	33	10	7	33	10	7
10		2	48	5	9	36	3	17	30	11	17	22	24	20	6	36	11	3	46	3	1
Σ	5	20	475	15	72	413	54	121	325	117	149	234	242	165	93	323	116	61	413	56	31

TABLE 7—*Frequencies of Different Classes of Judgment—With Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1			50		11	39	6	13	31	8	15	27	19	23	8	34	13	3	41	8	1
2			50		2	48	1	15	34	5	23	22	19	22	9	38	11	1	45	5	
3		1	49		2	48	3	11	36	5	24	21	19	25	6	39	10	1	41	9	
4	1	5	44		3	47		12	38	2	13	35	21	23	6	26	16	8	39	9	2
5			50		1	49	1	10	39	3	18	29	23	21	6	30	14	6	44	5	1
6		2	48		1	49	4	5	41	6	11	33	30	15	5	29	13	8	40	10	
7		2	48		1	49	3	3	44	11	12	27	30	16	4	41	8	1	46	3	1
8			50		2	48		9	41	7	10	33	28	15	7	41	7	2	45	3	2
9	1		49		1	49	1	6	43	17	12	21	37	7	6	41	4	5	49	1	
10	1		49	2	8	40	6	8	36	19	20	11	30	9	11	43	4	3	46	2	2
Σ	3	10	487	2	32	466	25	92	383	83	158	259	256	176	68	362	100	38	436	55	9

TABLE 8—*Frequencies of the Different Classes of Judgments—With Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	4	45	5	8	37	4	12	34	19	16	15	23	16	11	36	10	4	41	5	4
2		7	43	6	17	27	10	19	21	19	22	9	25	16	9	38	9	3	40	10	
3		4	46	2	17	31	8	15	27	20	19	11	18	26	6	41	7	2	42	7	1
4	1	3	46	1	5	44	3	8	39	19	13	18	26	13	11	42	6	2	44	5	1
5	4	1	45	4	5	41	7	7	36	18	14	18	35	7	8	41	7	2	43	4	3
6			50	2	7	41	2	5	43	18	14	18	21	17	12	45	3	2	48	2	
7	2	1	47	2	1	47	4	15	31	18	8	24	37	8	5	45	3	2	47	3	
8	2	4	44	5	3	42	7	9	34	21	11	18	35	8	7	41	3	6	49		1
9		1	49	2	4	44	4	6	40	14	10	26	42	4	4	46	4		50		
10	1		49	2	2	46	9	8	33	27	8	15	43	4	3	38	8	4	46	3	1
Σ	11	25	464	31	69	400	58	104	338	193	135	172	305	119	76	413	60	27	450	39	11

TABLE 9—*Frequencies of the Different Classes of Judgment—Without Sound—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	1	8	41	8	8	34	12	14	24	12	18	20	35	11	4	31	17	2	45	4	1
12	3	5	42	5	14	31	7	14	29	22	16	12	27	18	5	33	15	2	43	6	1
13	3	2	45	1	11	38	12	9	29	18	16	16	32	12	6	41	5	4	47	2	1
14	1	2	47	3	7	40	9	10	31	21	11	18	35	10	5	36	9	5	46	4	
15		6	44	2	14	34	5	17	28	16	14	20	35	8	7	36	9	5	48	1	1
16		5	45		14	36	5	10	35	19	12	19	37	5	8	29	17	4	47	2	1
Σ	8	28	264	19	68	213	50	74	176	108	87	105	201	64	35	206	72	22	276	19	5

TABLE 10—*Frequencies of the Different Classes of Judgments—Without Sound—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	1	5	44	3	3	44	8	14	28	10	24	16	29	12	9	36	10	4	42	7	1
12	1	5	44	3	4	43	13	18	19	22	12	16	35	7	8	37	9	4	45	4	1
13		3	47	3	10	37	8	23	19	21	14	15	32	12	6	36	12	2	42	7	1
14		4	46	7	7	36	13	10	27	18	17	15	32	10	8	43	3	4	43	7	
15	1	8	41	4	8	38	17	5	28	27	12	11	32	14	4	38	9	3	43	6	1
16	2	5	43	9	8	33	10	16	24	16	16	18	33	9	8	32	9	9	43	3	4
Σ	5	30	265	29	40	231	69	86	145	114	95	91	193	64	43	222	52	26	258	34	8

TABLE 11—*Frequencies of the Different Classes of Judgments—Without Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11		2	48	1	2	47	12	9	29	12	14	24	28	12	10	28	16	6	46	2	2
12			50	4	1	45	6	12	32	11	11	28	32	11	7	34	11	5	46	4	
13		1	49			50	9	12	29	10	11	29	26	12	12	31	16	3	42	6	2
14	1	3	46		3	47	1	10	39	18	15	17	36	8	6	32	12	6	48	1	1
15			50	4	5	41	3	15	32	14	18	18	29	15	6	32	9	9	41	7	2
16		6	44	2	5	43	6	7	37	24	12	14	32	14	4	32	14	4	44	5	1
Σ	1	12	287	11	16	273	37	65	198	89	81	130	183	72	45	189	78	33	267	25	8

TABLE 12—*Frequencies of the Different Classes of Judgment—Without Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	1	1	48		13	37	6	9	35	25	19	6	35	11	4	46	4		47	2	1
12	1	2	47	2	12	36	7	6	37	26	16	8	36	11	3	48	1	1	50		
13			50	1	9	40	4	18	28	19	18	13	37	12	1	46	4		48	2	
14	1		49	4	6	40	8	10	32	17	18	15	31	13	6	46	4		45	2	3
15			50	1	4	45	5	7	38	16	14	20	28	11	11	37	10	3	46	4	
16		1	49	4	5	41	4	10	36	19	17	14	20	16	14	36	12	2	43	5	2
Σ	3	4	293	12	49	239	34	60	206	122	102	76	187	74	39	259	35	6	279	15	6

TABLE 13—*Frequencies of the Different Classes of Judgment—With Sound—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	1	2	47	3	8	39	7	13	30	12	15	23	28	13	9	43	6	1	47	2	1
12		6	44	5	12	33	12	8	30	14	22	14	30	14	6	45	5		50		
13		1	49	1	12	37	8	21	21	23	18	9	36	8	6	41	9		47	3	
14	2	3	45	2	11	37	11	13	26	14	23	13	29	10	11	38	10	2	43	5	2
15	1	5	44	3	7	40	7	14	29	15	17	18	36	13	1	37	12	1	48		2
16	1	6	43	6	5	39	9	15	26	10	30	10	41	4	5	42	8		47	3	
Σ	5	23	272	20	55	225	54	84	162	88	125	87	200	62	38	246	50	4	282	13	5

TABLE 14—*Frequencies of the Different Classes of Judgments—With Sounds—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	2	2	46	4	4	42	10	15	25	14	13	23	28	18	4	40	7	3	45	3	2
12	2	4	44	6	10	34	13	12	25	20	13	17	33	9	8	38	8	4	43	4	3
13		3	47	4	11	35	18	10	22	16	13	21	33	8	9	36	5	9	44	3	3
14		4	46	8	7	35	12	8	30	22	6	22	32	11	7	34	5	11	44		6
15	2	5	43	7	10	33	14	7	29	21	10	19	36	7	7	38	5	7	41	4	5
16	3	7	40	7	7	36	9	6	35	16	14	20	29	11	10	40	5	5	45	3	2
Σ	9	25	266	36	49	215	76	58	166	109	69	122	191	64	45	226	35	39	262	17	21

TABLE 15—*Frequencies of the Different Classes of Judgments—With Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11	2	1	47	2	1	47	5	9	36	21	8	21	35	6	9	44	3	3	49	1	
12			50	3	1	46	12	2	36	15	11	24	24	13	13	44	4	2	44	4	2
13		1	49	1	2	47	7	13	30	13	11	26	31	9	10	32	13	5	47	2	1
14	1	1	48	3		47	8	1	41	17	8	25	41	7	2	44	2	4	45	3	2
15	1	2	47	4	2	44	6	3	41	19	14	17	35	9	6	42	5	3	46	3	1
16	4	3	43	2	2	46	9	8	33	14	14	22	43	4	3	40	8	2	45	4	1
Σ	8	8	284	15	8	277	47	36	217	99	66	135	209	48	43	246	35	19	276	17	7

TABLE 16—*Frequencies of the Different Classes of Judgment—With Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
11		2	48	5	8	37	7	16	27	25	16	9	40	8	2	43	7		46	2	2
12		2	48	3	5	42	8	7	35	27	12	11	40	9	1	45	4	1	45	4	1
13		1	49	1	11	38	13	11	26	27	15	8	44	3	3	49		1	50		
14		3	47	4	5	41	5	12	33	26	13	11	26	16	8	45	5		48	2	
15	2		48	3	5	42	6	7	37	24	11	15	32	9	9	46	1	3	50		
16	1		49	2	7	41	11	9	30	20	20	10	32	10	8	48	2		50		
Σ	3	8	289	18	41	241	50	62	188	149	87	64	214	55	31	276	19	5	289	8	3

TABLE 17—*Frequencies of the Different Classes of Judgment—Without Sounds—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17		5	45	6	7	37	8	11	31	13	25	12	21	17	12	34	12	4	47	3	
18	3	5	42	1	11	38	8	5	37	17	20	13	27	16	7	28	18	4	46	3	1
19		3	47	1	5	44	6	11	33	8	15	27	16	17	17	24	15	11	42	7	1
20		4	46	1	9	40	6	8	36	13	16	21	25	14	11	27	13	10	42	6	2
21		4	46	1	8	41	3	11	36	13	13	24	31	12	7	29	13	8	46	3	1
22		2	48		5	45	3	9	38	9	16	25	22	16	12	20	16	14	44	4	2
Σ	3	23	274	10	45	245	34	55	211	73	105	122	142	92	66	162	87	51	267	26	7

TABLE 18—*Frequencies of the Different Classes of Judgment—Without Sound—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17	1	5	44	9	6	35	15	15	20	21	14	15	38	7	5	40	8	2	49	1	
18	1	7	42	7	9	34	12	13	25	22	14	14	33	12	5	40	8	2	45	3	2
19		5	45	3	7	40	12	14	24	20	12	18	39	8	3	41	7	2	50		
20		5	45	3	6	41	16	11	23	20	17	13	34	12	4	39	6	5	43	7	
21	1	6	43	6	12	32	9	19	22	19	17	14	39	9	2	36	9	5	48	2	
22	1	7	42	3	16	31	6	16	28	20	16	14	33	13	4	35	12	3	43	6	1
Σ	4	35	261	31	56	213	70	88	142	122	90	88	216	61	23	231	50	19	278	19	3

TABLE 19—*Frequencies of the Different Classes of Judgment—Without Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17		3	47	1	3	46	5	8	37	9	16	25	33	11	6	37	12	1	49		1
18	1	5	44	2	1	47	5	12	33	16	8	26	31	12	7	32	13	5	46	4	
19	1		49	3	4	43	6	11	33	12	13	25	24	16	10	36	11	3	46	3	1
20		2	48		1	49	1	9	40	14	16	20	25	16	9	27	17	6	43	7	
21		1	49		1	49	5	10	35	7	26	17	30	19	1	31	15	4	44	4	2
22			50		3	47	7	10	33	13	14	23	23	19	8	22	24	4	47	3	
Σ	2	11	287	6	13	281	29	60	211	71	93	136	166	93	41	185	92	23	275	21	4

TABLE 20—*Frequencies of the Different Classes of Judgment—Without Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17		1	49	2	4	44	9	8	33	17	16	17	33	14	3	39	7	4	49	1	
18			50	3	5	42	2	14	34	11	20	19	27	18	5	40	8	2	44	5	1
19		2	48	1	6	43	2	18	30	18	17	15	30	15	5	37	11	2	47	2	1
20	1	1	48	1	4	45	4	10	36	18	16	16	28	12	10	34	11	5	47	2	1
21	1	1	48	2	7	41	1	12	37	18	23	9	30	14	6	38	9	3	45	5	
22	1	4	45	3	8	39	4	13	33	13	18	19	30	15	5	39	10	1	47	2	1
Σ	3	9	288	12	34	254	22	75	203	95	110	95	178	88	34	227	56	17	279	17	4

TABLE 21—*Frequencies of the Different Classes of Judgments—With Sound—Subject I*

	88			91			94			97			100			103			106		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17	1	5	44	4	9	37	5	13	32	15	21	14	30	12	8	42	6	2	48	2	
18		6	44	3	12	35	9	9	32	19	18	13	14	16	20	41	6	3	47	2	1
19		2	48	1	5	44	2	10	38	12	23	15	18	23	9	36	12	2	45	4	1
20		6	44	1	6	43	5	10	35	9	18	23	22	22	6	31	14	5	37	11	2
21	1	3	46		8	42	5	10	35	9	20	21	24	14	12	39	9	2	43	5	2
22	1		49	1	6	43	1	9	40	4	19	27	26	13	11	32	12	6	36	13	1
Σ	3	22	275	10	46	244	27	61	212	68	119	113	134	100	66	221	59	20	256	37	7

TABLE 22—*Frequencies of the Different Classes of Judgments—With Sound—Subject II*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17		3	47	5	9	36	19	11	20	28	11	11	39	11		36	11	3	46	2	2
18		1	49	1	4	45	12	11	27	29	11	10	36	9	5	44	3	3	46	2	2
19		2	48	8	7	35	22	9	19	27	13	10	41		9	43	4	3	45	4	1
20	3	2	45	2	4	44	5	14	31	21	11	18	35	6	9	39	8	3	45	4	1
21	1	7	42	5	14	31	11	14	25	21	18	11	34	13	3	38	7	5	41	6	3
22		6	44	2	7	41	9	16	25	17	19	14	30	15	5	36	9	5	46	3	1
Σ	4	21	275	23	45	232	78	75	147	143	83	74	215	54	31	236	42	22	269	21	10

TABLE 23—*Frequencies of the Different Classes of Judgments—With Sound—Subject III*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17			50	2	5	43	13	8	29	20	7	23	43	2	5	43	4	3	49	1	
18	1		49	1	4	45	7	8	35	22	13	15	27	14	9	44	4	2	48	2	
19			50	1	4	45	11	13	26	13	10	27	25	13	12	37	9	4	45	3	2
20		2	48		2	48	6	9	35	6	16	28	25	18	7	33	11	6	46	3	1
21		1	49		1	49	2	9	39	8	15	27	35	13	2	29	16	5	42	8	
22			50	1	3	46		8	42	8	17	25	26	22	2	31	13	6	45	5	
Σ	1	3	296	5	19	276	39	55	206	77	78	145	181	82	37	217	57	26	275	22	3

TABLE 24—*Frequencies of the Different Classes of Judgment—With Sound—Subject IV*

	84			88			92			96			100			104			108		
Series	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
17		3	47	4	8	38	3	7	40	17	22	11	35	12	3	44	4	2	40	10	
18			50		5	45	4	9	37	15	19	16	31	13	6	43	7		44	6	
19			50	2	1	47	2	9	39	18	18	14	23	20	7	40	7	3	46	3	1
20	1	1	48		1	49	1	5	44	11	21	18	27	15	8	34	8	8	48	2	
21	1	1	48	1	5	44	1	7	42	9	15	26	24	15	11	41	6	3	43	3	4
22			50		2	48	3	8	39	13	22	15	22	21	7	40	8	2	46	4	
Σ	2	5	293	7	22	271	14	45	241	83	117	100	162	96	42	242	40	18	267	28	5

TABLE 25—*Frequencies of the Different Classes of Judgments with Selected Sounds on Comparison Weight—Subject I*

	88			91			94			97			100			103			106		
No. of S.	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	3	46	1	15	34	9	13	28	14	25	11	36	9	5	41	9		46	3	1
2	1	3	46	1	12	37	10	21	19	11	24	15	38	9	3	33	16	1	49	1	
3		5	45	3	6	41	10	14	26	24	14	12	28	14	8	45	5		44	3	3
4	1	1	48	6	5	39	8	10	32	14	21	15	34	9	7	43	7		48	2	
5	2	6	42	5	12	33	7	19	24	13	20	17	30	12	8	40	9	1	48	2	
6		5	45	4	5	41	10	7	33	12	21	17	34	9	7	44	4	2	47	2	1
Σ	5	23	272	20	55	225	54	84	162	88	125	87	200	62	38	246	50	4	282	13	5

TABLE 26—*Frequences of the Different Classes of Judgment with Selected Sounds on Comparison Weight—Subject II*

	84			88			92			96			100			104			108		
No. of S.	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	2	47	8	6	36	10	10	30	23	8	19	34	12	4	33	5	12	44	1	5
2	1	2	47	5	6	39	16	9	25	11	14	25	29	13	8	41	3	6	43	5	2
3	2	5	43	8	9	33	14	7	29	18	12	20	30	13	7	35	7	8	42	2	6
4	3	8	39	3	7	40	13	12	25	20	8	22	32	9	9	39	8	3	46	3	1
5	1	5	44	8	11	31	12	10	28	21	15	14	38	4	8	39	5	6	44	2	4
6	1	3	46	4	10	36	11	10	29	16	12	22	28	13	9	39	7	4	43	4	3
Σ	9	25	266	36	49	215	76	58	166	109	69	122	191	64	45	226	35	39	262	17	21

TABLE 27—*Frequencies of the Different Classes of Judgment with Selected Sounds on Comparison Weight—Subject III*

	84			88			92			96			100			104			108		
No. of S.	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		2	48	2		48	6	3	41	15	15	20	35	9	6	42	3	5	45	3	2
2	2		48	1	1	48	11	6	33	16	8	26	34	11	5	41	9		42	6	2
3	2		48	4	3	43	9	6	35	14	13	23	35	9	6	41	7	2	47	2	1
4	2	3	45	2	1	47	7	4	39	14	15	21	33	7	10	37	8	5	44	4	2
5	1	3	46	3	2	45	9	7	34	20	8	22	32	8	10	40	6	4	48	2	
6	1		49	3	1	46	5	10	35	20	7	23	40	4	6	45	2	3	50		
Σ	8	8	284	15	8	277	47	36	217	99	66	135	209	48	43	246	35	19	276	17	7

TABLE 28—*Frequencies of the Different Classes of Judgments with Selected Sounds on Comparison Weight—Subject IV*

	84			88			92			96			100			104			108		
No. of S.	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		1	49	3	6	41	11	7	32	16	19	15	34	11	5	46	3	1	49	1	
2		1	49	1	6	43	3	16	31	25	14	11	36	9	5	46	3	1	48	2	
3	1	2	47	4	3	43	5	9	36	21	18	11	38	8	4	48	2		46	3	1
4	1	1	48	2	11	37	11	11	28	28	13	9	33	13	4	45	5		49	1	
5	1	1	48	5	6	39	10	8	32	31	12	7	36	5	9	46	3	1	49	1	
6		2	48	3	9	38	10	11	29	28	11	11	37	9	4	45	3	2	48		2
Σ	3	8	289	18	41	241	50	62	188	149	87	64	214	55	31	276	19	5	289	8	3

TABLE 29—*Frequencies of Different Classes of Judgments with Selected Sounds on Standard Weight—Subject I*

No. of S.	88			91			94			97			100			103			106		
	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		5	45	2	10	38	3	13	34	13	18	19	25	15	10	37	12	1	43	5	2
2		1	49	1	5	44	3	11	36	12	15	23	23	17	10	36	11	3	43	7	
3	1	6	43	2	4	44	8	8	34	8	26	16	20	20	10	40	8	2	40	10	
4	1	4	45	2	6	42	4	13	33	12	20	18	24	14	12	33	12	5	42	6	2
5		2	48		10	40	4	12	34	13	21	16	20	14	16	38	7	5	43	6	1
6	1	4	45	3	11	36	5	4	41	10	19	21	22	20	8	37	9	4	45	3	2
Σ	3	22	275	10	46	244	27	61	212	68	119	113	134	100	66	221	59	20	256	37	7

TABLE 30—*Frequencies of the Different Classes of Judgment with Selected Sounds on Standard Weight—Subject II*

No. of S.	84			88			92			96			100			104			108		
	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1	3	46	5	8	37	16	15	19	23	19	8	40	7	3	45	5		48	2	
2	3	2	45	6	10	34	19	9	22	26	9	15	36	9	5	35	9	6	47	3	
3		6	44	6	8	36	11	12	27	23	11	16	41	6	3	42	5	3	45	3	2
4		3	47	3	9	38	12	12	26	31	13	6	37	8	5	40	8	2	47	3	
5		3	47	2	6	42	11	14	25	18	15	17	29	11	10	36	6	8	38	8	4
6		4	46	1	4	45	9	13	28	22	16	12	32	13	5	38	9	3	44	2	4
Σ	4	21	275	23	45	232	78	75	147	143	83	74	215	54	31	236	42	22	269	21	10

TABLE 31—*Frequencies of the Different Classes of Judgment with Selected Sounds on the Standard Weight—Subject III*

No. of S.	84			88			92			96			100			104			108		
	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1	1		49		6	44	6	7	37	17	7	26	33	11	6	35	9	6	46	4	
2		2	48		4	46	8	11	31	11	16	23	33	11	6	34	10	6	48	1	1
3		1	49	1	1	48	7	10	33	11	18	21	28	16	6	38	7	5	45	4	1
4			50	1	1	48	8	5	37	14	10	26	30	11	9	38	10	2	43	7	
5			50	3	4	43	6	11	33	11	12	27	30	17	3	37	10	3	46	3	1
6			50		3	47	4	11	35	13	15	22	27	16	7	35	11	4	47	3	
Σ	1	3	296	5	19	276	39	55	206	77	78	145	181	82	37	217	57	26	275	22	3

TABLE 32—*Frequencies of the Different Classes of Judgment with Selected Sounds on Standard Weight—Subject IV*

No. of S.	84			88			92			96			100			104			108		
	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l	h	e	l
1		1	49		5	45	2	7	41	15	21	14	35	10	5	39	8	3	46	2	2
2		1	49		4	46	4	8	38	17	21	12	25	18	7	38	9	3	46	3	1
3			50	2	4	44	1	9	40	12	22	16	25	24	1	40	6	4	46	4	
4		2	48		5	45	4	8	38	13	21	16	28	13	9	41	6	3	43	7	
5	1	1	48	3	3	44	1	8	41	9	16	25	24	15	11	40	6	4	44	6	
6	1		49	2	1	47	2	5	43	17	16	17	25	16	9	44	5	1	42	6	2
Σ	2	5	293	7	22	271	14	45	241	83	117	100	162	96	42	242	40	18	267	28	5

TABLE 33—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject I*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
1	0.1092	0.1307	95.39	95.09	0.1222	0.1656	100.36	97.46	4.97	2.37	98.02	96.42
2	0.1136	0.1468	96.20	94.64	0.1276	0.1566	100.21	97.73	4.01	3.09	98.32	96.23
3	0.1199	0.1598	96.31	93.14	0.1354	0.1841	100.48	96.66	4.17	3.52	98.52	95.03
4	0.0949	0.1464	95.57	94.30	0.1068	0.1452	100.48	97.74	4.91	3.44	98.17	96.01
5	0.1200	0.1336	95.20	93.51	0.1267	0.1340	99.27	97.59	4.07	4.08	97.29	95.55
6	0.1223	0.1272	96.22	94.00	0.1351	0.1255	99.51	97.63	3.29	3.63	97.95	95.80
7	0.1252	0.1380	95.46	93.27	0.1389	0.1500	100.30	97.10	4.84	3.83	98.01	95.26
8	0.1288	0.1432	95.47	94.06	0.1012	0.1731	100.44	97.16	4.97	3.10	97.66	95.76
9	0.1185	0.1262	95.98	94.03	0.1246	0.1676	101.48	97.65	5.50	3.62	98.80	96.10
10	0.1339	0.1516	96.21	93.62	0.1176	0.1554	101.63	97.53	5.42	3.91	98.74	95.60
A	0.1186	0.1404	95.80	93.98	0.1236	0.1558	100.42	97.42	4.62	3.46	98.15	95.78

TABLE 34—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject II*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
1	0.0940	0.1014	93.10	93.53	0.0906	0.1132	102.38	98.05	9.28	4.52	97.66	95.91
2	0.0965	0.1022	94.87	94.77	0.0809	0.0900	102.03	100.46	7.16	5.69	98.14	97.43
3	0.0943	0.1142	95.92	95.62	0.0997	0.0938	103.42	100.60	7.50	4.98	99.78	97.87
4	0.0982	0.0922	94.60	95.02	0.0895	0.0934	102.91	101.05	8.31	6.03	98.56	98.05
5	0.0826	0.1042	94.09	95.40	0.0904	0.1040	103.01	101.17	8.92	5.77	98.75	98.28
6	0.0797	0.0850	95.41	94.92	0.0674	0.0942	106.81	101.27	11.40	6.35	100.63	98.26
7	0.0888	0.0972	96.81	95.90	0.0658	0.0955	106.38	102.00	9.57	6.10	100.88	98.92
8	0.0973	0.0814	93.99	96.65	0.0569	0.0740	105.73	102.90	11.74	6.25	98.32	99.63
9	0.0900	0.0898	93.76	95.42	0.0903	0.0820	100.68	102.24	6.92	6.82	97.23	98.68
10	0.1047	0.1046	92.22	93.56	0.1094	0.1018	98.44	100.00	6.22	6.44	95.40	96.74
A	0.0926	0.0972	94.48	95.08	0.0841	0.0942	103.18	101.01	8.70	5.90	98.54	97.98

TABLE 35—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject III*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
1	0.0864	0.1028	91.81	94.33	0.0842	0.1014	103.15	101.55	11.34	7.22	97.41	97.92
2	0.1032	0.1472	92.74	95.09	0.1192	0.1549	102.35	101.44	9.61	6.35	97.90	98.35
3	0.1096	0.1542	93.07	94.84	0.0991	0.1252	102.20	101.60	9.13	6.76	97.40	97.87
4	0.1002	0.0964	93.30	96.30	0.1025	0.0931	101.78	102.92	8.48	6.62	97.59	99.55
5	0.1188	0.1353	93.60	96.49	0.1292	0.1411	100.80	102.02	7.20	5.53	97.35	99.31
6	0.0956	0.1196	96.23	96.93	0.1110	0.1008	101.45	101.54	5.22	4.61	99.03	99.04
7	0.1155	0.1434	94.94	95.83	0.1033	0.1356	98.49	99.56	3.55	3.73	96.62	97.64
8	0.1169	0.1410	95.08	96.76	0.1242	0.1398	99.17	101.18	4.09	3.42	97.19	98.46
9	0.1323	0.1425	94.37	95.92	0.1168	0.1288	97.71	97.96	3.34	2.04	95.94	96.89
10	0.1337	0.1074	93.07	94.20	0.1346	0.1136	97.64	98.30	4.57	4.10	95.36	96.31
A	0.1112	0.1290	93.82	95.67	0.1124	0.1234	100.47	100.71	6.65	5.04	97.18	98.13

TABLE 36—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject IV*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
1	0.0871	0.0857	91.78	93.88	0.0820	0.0863	99.42	100.01	7.64	6.13	95.49	96.96
2	0.0916	0.0843	91.76	90.44	0.1036	0.0762	98.68	99.21	6.92	8.77	95.43	94.60
3	0.0974	0.1006	92.55	91.70	0.1054	0.0940	98.23	99.72	5.68	8.02	95.50	95.57
4	0.1110	0.1132	93.82	94.76	0.1052	0.1106	98.67	99.21	4.85	4.45	96.18	96.96
5	0.1205	0.0932	94.54	94.18	0.1292	0.0886	98.41	97.94	3.87	3.76	96.54	96.01
6	0.1298	0.1194	93.21	95.07	0.1354	0.1326	96.85	99.04	3.64	3.97	95.07	97.16
7	0.1078	0.1268	94.41	94.39	0.1059	0.1188	98.16	97.51	3.75	3.12	96.30	95.90
8	0.1135	0.0978	92.88	94.04	0.1404	0.1071	97.17	97.18	4.29	3.14	95.26	95.68
9	0.1054	0.1400	93.15	95.16	0.1125	0.1623	97.14	97.34	3.99	2.18	95.21	96.33
10	0.1044	0.1277	93.41	94.30	0.0980	0.1047	98.02	97.00	4.61	2.70	95.64	95.52
A	0.1068	0.1089	93.15	93.79	0.1118	0.1081	98.08	98.42	4.92	4.62	95.66	96.07

TABLE 37—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject I*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
11	0.1219	0.1420	93.80	95.46	0.1072	0.1515	99.06	99.02	5.26	3.56	96.26	97.30
12	0.1258	0.1324	93.54	94.12	0.1053	0.1399	99.37	98.26	5.83	4.14	96.20	96.25
13	0.1334	0.1679	94.75	93.82	0.1310	0.1548	98.18	98.17	3.43	4.35	96.45	95.91
14	0.1422	0.1237	95.31	94.55	0.1327	0.1211	98.57	99.30	3.26	4.75	96.88	96.90
15	0.1179	0.1366	94.64	94.73	0.1575	0.1472	99.05	98.74	4.41	4.01	97.16	96.81
16	0.1289	0.1514	95.23	93.84	0.1301	0.1430	99.23	98.18	4.00	4.34	97.24	95.95
A	0.1284	0.1423	94.54	94.42	0.1273	0.1429	98.91	98.61	4.36	4.19	96.70	96.52

TABLE 38—*Values of h and S., Interval of Uncertainty, and Point of Subjective Equality—Subject II*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
11	0.1005	0.1024	93.52	93.61	0.0940	0.0942	99.94	98.67	6.42	5.06	96.62	96.03
12	0.0970	0.0826	92.62	92.47	0.0935	0.0823	97.69	97.84	5.07	5.37	95.11	95.15
13	0.1050	0.0766	92.05	93.34	0.0888	0.0800	98.80	97.87	6.75	4.53	95.14	95.66
14	0.0974	0.0710	92.80	94.42	0.0867	0.0760	97.98	98.28	5.18	3.86	95.24	96.41
15	0.0990	0.0722	91.71	93.07	0.0819	0.0778	97.18	97.55	5.47	4.48	94.18	95.39
16	0.0696	0.0801	92.60	93.45	0.0752	0.0864	98.77	98.19	6.17	4.74	95.80	95.91
A	0.0948	0.0808	92.55	93.39	0.0867	0.0828	98.39	98.06	5.84	4.67	95.35	95.76

TABLE 39—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject III*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
11	0.1022	0.1218	95.24	94.99	0.0888	0.1216	100.06	97.23	4.82	2.24	97.48	96.11
12	0.1148	0.1130	95.32	95.77	0.1016	0.0975	99.43	98.73	4.11	2.96	97.25	97.14
13	0.1056	0.1160	95.34	95.44	0.0872	0.1090	100.67	99.66	5.33	4.22	97.75	97.48
14	0.1128	0.1234	94.91	95.83	0.1067	0.1122	98.88	97.49	3.97	1.66	96.84	96.62
15	0.0906	0.1220	94.27	94.64	0.0898	0.1093	100.42	97.82	6.15	3.18	97.33	96.14
16	0.1087	0.1096	93.66	93.82	0.0920	0.0958	98.95	97.55	5.29	3.73	96.08	95.56
A	0.1058	0.1176	94.79	95.08	0.0944	0.1076	99.74	98.08	4.94	3.00	97.12	96.51

TABLE 40—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject IV*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
11	0.1234	0.1098	92.66	92.23	0.1190	0.1071	97.00	96.72	4.34	4.49	94.79	94.45
12	0.1333	0.1331	92.43	93.33	0.1400	0.1094	96.40	96.66	3.97	3.33	94.46	94.83
13	0.1495	0.1413	92.42	92.01	0.1417	0.1698	97.24	95.26	4.82	3.25	94.76	93.78
14	0.1024	0.1216	93.91	93.34	0.1073	0.1150	97.98	97.51	4.07	4.17	95.99	95.37
15	0.1273	0.1199	95.32	94.34	0.1157	0.1169	99.45	97.02	4.13	2.68	97.29	95.66
16	0.1075	0.1500	94.69	92.76	0.0921	0.1260	100.10	96.98	5.41	4.22	97.18	94.69
A	0.1239	0.1293	93.57	93.00	0.1193	0.1240	98.03	96.69	4.46	3.69	95.74	94.80

TABLE 41—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject I*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
17	0.1240	0.1365	94.94	94.62	0.1173	0.1524	99.92	98.75	4.98	4.13	97.36	96.80
18	0.1279	0.1101	94.82	95.26	0.1108	0.1345	99.96	99.51	5.14	4.25	97.20	97.59
19	0.1187	0.1655	97.37	95.93	0.1254	0.1634	102.10	100.72	4.73	4.79	99.80	98.31
20	0.1171	0.1304	96.44	95.91	0.1233	0.1233	100.96	101.62	4.52	5.71	98.76	98.66
21	0.1295	0.1360	96.27	96.07	0.1397	0.1418	100.50	100.25	4.23	4.18	98.46	98.20
22	0.1261	0.1516	97.65	97.09	0.1366	0.1287	101.90	101.73	4.25	4.64	99.86	99.22
A	0.1239	0.1384	96.25	95.81	0.1255	0.1407	100.89	100.43	4.64	4.62	98.57	98.13

TABLE 42—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject II*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
17	0.1026	0.0955	91.50	91.89	0.0956	0.0796	96.18	95.82	4.68	3.93	93.76	93.67
18	0.0843	0.1152	91.46	93.42	0.0902	0.1051	97.30	96.43	5.84	3.01	94.48	94.86
19	0.1135	0.0974	92.51	91.76	0.1114	0.0809	96.96	94.59	4.45	2.83	94.71	93.04
20	0.1031	0.1064	92.48	93.96	0.0842	0.0976	97.54	98.01	5.06	4.05	94.76	95.90
21	0.0894	0.0800	91.26	91.17	0.0995	0.0844	97.51	98.21	6.25	7.04	94.54	94.78
22	0.0920	0.0986	91.48	92.69	0.0944	0.1019	98.98	98.88	7.50	6.19	95.28	95.84
A	0.0975	0.0988	91.78	92.48	0.0959	0.0916	97.41	96.99	5.63	4.51	94.59	94.68

TABLE 43—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject III*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
17	0.1252	0.1186	94.98	94.09	0.1336	0.1250	99.33	96.44	4.35	2.35	97.22	95.29
18	0.1006	0.1347	94.88	94.47	0.1021	0.1197	99.55	97.98	4.67	3.51	97.23	96.12
19	0.1160	0.0996	95.09	94.97	0.1021	0.1000	99.89	99.50	4.80	4.53	97.34	97.24
20	0.1221	0.1180	95.76	95.83	0.1008	0.1164	101.30	100.70	5.54	4.87	98.27	98.25
21	0.1230	0.1384	94.94	95.98	0.1098	0.1087	100.72	100.94	5.78	4.96	97.67	98.16
22	0.1263	0.1310	95.17	95.94	0.0870	0.1172	101.47	101.00	6.30	5.04	97.74	98.33
A	0.1189	0.1234	95.14	95.21	0.1059	0.1145	100.38	99.43	5.24	4.21	97.58	97.23

TABLE 44—*Values of h and S., Interval of Uncertainty and Point of Subjective Equality—Subject IV*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Series	Sound		Sound		Sound		Sound		Sound		Sound	
17	0.1293	0.1277	96.16	93.14	0.1166	0.0978	98.12	98.73	1.96	5.59	96.04	95.56
18	0.1217	0.1527	94.08	94.34	0.1132	0.1186	99.86	99.06	5.78	4.72	96.86	96.40
19	0.1228	0.1362	93.57	94.96	0.1236	0.1178	99.24	99.51	5.67	4.55	96.42	97.07
20	0.1150	0.1204	94.93	96.05	0.1083	0.1168	99.46	100.11	4.53	4.06	97.13	98.05
21	0.1262	0.1070	93.60	96.31	0.1079	0.1150	99.11	100.42	5.51	4.11	96.14	98.44
22	0.1096	0.1586	93.33	94.96	0.1126	0.1303	99.03	100.08	5.70	5.12	96.22	97.27
A	0.1208	0.1338	94.28	94.96	0.1137	0.1160	99.14	99.65	4.86	4.69	96.47	97.13

TABLE 45—*Values of h and S., etc., with Selected Sounds on S and C Weights—Subject I*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	Sounds		Sounds		Sounds		Sounds		Sounds		Sounds	
No. of S	on S S	on C S	on S S	on C S	on S S	on C S	on S S	on C S	on S S	on C S	on S S	on C S
1	0.1293	0.1425	95.39	94.01	0.1452	0.1507	100.23	98.66	4.84	4.65	97.95	96.40
2	0.1642	0.1603	96.42	93.71	0.1520	0.1427	100.55	99.06	4.13	5.35	98.41	96.23
3	0.1381	0.1240	95.34	94.77	0.1263	0.1318	100.61	98.32	5.27	3.55	97.86	96.60
4	0.1260	0.1602	95.85	95.05	0.1294	0.1464	100.66	98.20	4.81	3.15	98.28	96.55
5	0.1318	0.1208	96.08	93.81	0.1490	0.1354	100.48	98.78	4.40	4.97	98.41	96.44
6	0.1264	0.1450	95.73	95.17	0.1371	0.1514	100.20	98.37	4.47	3.20	98.06	96.80
A	0.1360	0.1421	95.80	94.42	0.1398	0.1431	100.45	98.56	4.65	4.14	98.16	96.50

TABLE 46—*Values of h and S., etc., with Selected Sounds on S and C Weights—Subject II*

No. of S	h_1 Sounds on S S	h_1 Sounds on C S	S_1 Sounds on S S	S_1 Sounds on C S	h_2 Sounds on S S	h_2 Sounds on C S	S_2 Sounds on S S	S_2 Sounds on C S	Interval of Uncertainty Sounds on S S	Interval of Uncertainty Sounds on C S	Point of Subjective Equality Sounds on S S	Point of Subjective Equality Sounds on C S
1	0.1358	0.0747	91.03	94.25	0.1117	0.1007	95.79	97.88	4.76	3.63	93.18	96.34
2	0.0886	0.0914	91.99	94.06	0.0811	0.0872	96.34	98.46	4.35	4.40	94.07	96.21
3	0.0952	0.0686	92.36	93.31	0.0960	0.0737	96.53	98.43	4.17	5.12	94.46	95.96
4	0.1229	0.0848	92.00	92.71	0.0999	0.0911	96.34	97.58	4.34	4.87	93.94	95.24
5	0.0831	0.0752	94.25	92.34	0.0771	0.0872	99.69	97.09	5.44	4.75	96.87	94.89
6	0.0987	0.0878	93.52	93.76	0.0974	0.0910	98.36	98.86	4.84	5.10	95.92	96.36
A	0.1040	0.0804	92.52	93.40	0.0939	0.0885	97.18	98.05	4.65	4.64	94.74	95.83

TABLE 47—*Values of h and S., etc., with Selected Sounds on S and C Weights—Subject III*

No. of S	h_1 Sounds on S S	h_1 Sounds on C S	S_1 Sounds on S S	S_1 Sounds on C S	h_2 Sounds on S S	h_2 Sounds on C S	S_2 Sounds on S S	S_2 Sounds on C S	Interval of Uncertainty Sounds on S S	Interval of Uncertainty Sounds on C S	Point of Subjective Equality Sounds on S S	Point of Subjective Equality Sounds on C S
1	0.1177	0.1215	95.59	95.68	0.1027	0.1164	98.89	98.52	3.30	2.84	97.13	97.07
2	0.1129	0.1180	94.94	95.31	0.1106	0.0931	99.21	98.38	4.27	3.07	97.05	96.66
3	0.1242	0.1220	95.12	94.62	0.1135	0.1042	99.68	97.83	4.56	3.21	97.30	96.10
4	0.1476	0.1074	95.74	95.24	0.1028	0.0974	99.42	99.03	3.68	3.79	97.25	97.05
5	0.1200	0.1074	94.75	94.88	0.1094	0.1093	99.40	97.81	4.65	2.93	96.96	96.36
6	0.1318	0.1349	95.21	95.00	0.1211	0.1333	99.92	96.88	4.71	1.88	97.47	95.94
A	0.1257	0.1185	95.22	95.12	0.1100	0.1090	99.42	98.08	4.20	2.95	97.19	96.53

TABLE 48—*Values of h and S., etc., with Selected Sounds on S and C Weights—Subject IV*

No. of S	h_1 Sounds on S S	h_1 Sounds on C S	S_1 Sounds on S S	S_1 Sounds on C S	h_2 Sounds on S S	h_2 Sounds on C S	S_2 Sounds on S S	S_2 Sounds on C S	Interval of Uncertainty Sounds on S S	Interval of Uncertainty Sounds on C S	Point of Subjective Equality Sounds on S S	Point of Subjective Equality Sounds on C S
1	0.1265	0.1375	94.91	93.42	0.1266	0.1268	99.04	97.18	4.13	3.76	96.97	95.22
2	0.1325	0.1459	94.64	93.24	0.1158	0.1423	99.56	97.34	4.92	4.10	96.93	95.27
3	0.1343	0.1273	94.64	93.51	0.1252	0.1181	99.85	97.10	5.21	3.59	97.15	95.24
4	0.1266	0.1362	94.74	92.10	0.1145	0.1212	99.72	96.50	4.98	4.40	97.11	94.17
5	0.1167	0.1238	95.84	92.98	0.1081	0.1204	100.16	95.78	4.32	2.80	97.92	94.36
6	0.1235	0.1090	95.55	92.76	0.1060	0.1196	99.52	96.32	3.97	3.56	97.39	94.62
A	0.1267	0.1300	95.05	93.00	0.1160	0.1247	99.64	96.70	4.59	3.70	97.24	94.81

TABLE 49—*Average of Series* 1—10 *for each Subject*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Sub	Sound		Sound		Sound		Sound		Sound		Sound	
I	0.1186	0.1404	95.80	93.98	0.1236	0.1558	100.42	97.42	4.62	3.46	98.15	95.78
II	0.0926	0.0972	94.48	95.08	0.0841	0.0942	103.18	101.01	8.70	5.90	98.54	97.98
III	0.1112	0.1290	93.82	95.67	0.1124	0.1234	100.47	100.71	6.65	5.04	97.18	98.13
IV	0.1068	0.1089	93.15	93.79	0.1118	0.1081	98.08	98.42	4.92	4.62	95.66	96.07
A	0.1073	0.1189	94.31	94.63	0.1080	0.1204	10054	99.39	6.22	4.76	97.38	96.99

TABLE 50—*Average of Series* 11—16 *for each Subject*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Sub	Sound		Sound		Sound		Sound		Sound		Sound	
I	0.1284	0.1423	94.54	94.42	0.1273	0.1429	98.91	98.61	4.36	4.19	96.70	96.52
II	0.0948	0.0808	92.55	93.39	0.0867	0.0828	98.39	98.06	5.84	4.67	95.35	95.76
III	0.1058	0.1176	94.79	95.08	0.0944	0.1076	99.74	98.08	4.94	3.00	97.12	96.51
IV	0.1239	0.1293	93.57	93.00	0.1193	0.1240	98.03	96.69	4.46	3.69	95.74	94.80
A	0.1132	0.1175	93.86	93.97	0.1069	0.1143	98.77	97.86	4.90	3.89	96.23	95.90

TABLE 51—*Average of Series* 17—22 *for each Subject*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
	−	+	−	+	−	+	−	+	−	+	−	+
Sub	Sound		Sound		Sound		Sound		Sound		Sound	
I	0.1239	0.1384	96.25	95.81	0.1255	0.1407	100.89	100.43	4.64	4.62	98.57	98.13
II	0.0975	0.0988	91.78	92.48	0.0959	0.0916	97.41	96.99	5.63	4.51	94.59	94.68
III	0.1189	0.1234	95.14	95.21	0.1059	0.1145	100.38	99.43	5.24	4.21	97.58	97.23
IV	0.1208	0.1338	94.28	94.96	0.1137	0.1160	99.14	99.65	4.86	4.69	96.47	97.13
A	0.1153	0.1236	94.36	94.62	0.1102	0.1157	99.46	99.12	5.09	4.51	96.80	96.79

TABLE 52—*Comparison of Results of Years* 1912 *and* 1913—*Subject I*

	h_1		S_1		h_2		S_2		Interval of Uncertainty		Point of Subjective Equality	
Series	1912	1913	1912	1913	1912	1913	1912	1913	1912	1913	1912	1913
1	0.1162	0.1186	94.11	95.80	0.1206	0.1236	99.69	100.42	5.58	4.62	96.99	98.15
2	0.1034	0.1284	94.58	94.54	0.1125	0.1273	99.51	98.91	4.93	4.36	97.15	96.70
3	0.1103	0.1239	95.10	96.25	0.1287	0.1255	99.62	100.89	4.52	4.64	97.55	98.57
A	0.1100	0.1236	94.60	95.53	0.1206	0.1255	99.61	100.07	5.01	4.54	97.23	97.80

TABLE 53—*Errors made on Numbers of Different Subjects*

	Numbers Given						Total
Sub	1	2	3	4	5	6	
III	1	2	2	4	9	4	22
IV		1	6	36	76	86	205
I	5	6	19	76	124	102	332
II	7	4	9	85	120	167	392
Σ	13	13	36	201	329	359	951

TABLE 54—*Errors of the Different Subjects on Numbers in Series with Discrete Sounds*

	SERIES											
Sub	1	2	3	4	5	6	7	8	9	10	11	12
I	52	40	29	26	28	31	28	19	19	22	23	15
II	41	41	44	27	49	37	35	48	31	23	8	8
III	3	3	1	1		2	1	1		9	1	
IV	47	17	16	25	14	25	16	23	6	4	5	7
Σ	143	101	90	79	91	95	80	91	56	58	37	30